Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

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Review Article

The global path forward – Healthy Living for Pandemic Event Protection (HL – PIVOT)☆

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Contents

The Merriam-Webster dictionary defines a pandemic as "an outbreak of a disease that occurs over a wide geographic area and affects an exceptionally high proportion of the population".[1] The world has again become acutely aware of this term because of a disease (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) that has dramatically changed our daily behaviors and habits. As of May 30th, 2020, there have been 5,775,043 confirmed cases and 361,220 confirmed deaths in 216 countries.[2] There will undoubtedly be lasting effects as a result of the COVID-19 pandemic, although how these lasting effects will impact daily life for the foreseeable future, as we begin to control viral spread and recover, remains uncertain at this time. One hope is that some of the lasting effects resulting from COVID-19 will be positive; we must learn from challenging times and try to make the world a better, healthier, and safer place for all inhabitants.

While certainly different from the current health crisis induced by COVID-19, we have been living with several other significant health conditions that continue to have catastrophic effects on a global scale. In fact, obesity,[3] physical inactivity,[4] diabetes[5] and other noncommunicable diseases (NCDs)[6] (e.g., cardiovascular disease, certain forms of cancer, and respiratory disease) have all been characterized as pandemics. Table 1 lists key metrics for each of these conditions according to the World Health Organization (WHO).[7–13] Clearly, the data listed in Table 1 make a strong case for each condition being characterized as a pandemic. These health conditions are also interrelated; for example, physical inactivity increases obesity risk which then increases risk for diabetes and other NCDs.[14,15] What is worse is that, while we have long recognized aggressively addressing the conditions in Table 1 is of paramount importance, we are making little impact in reversing trends; excess body weight, for example (i.e., obesity), continues to increase on a global scale.[16]

We have come to the point, based on overwhelming scientific evidence spanning several decades, that the importance and value of healthy living (HL) (i.e., physical activity, good nutrition, appropriate body weight and not smoking) in preventing (primary prevention) and treating (secondary prevention) the conditions listed in Table 1 is beyond dispute.[17–22] In fact, HL is the primary medicine to treat the obesity, physical inactivity/sedentarism, diabetes and NCD pandemics.[17,23] Moreover, and critically important to the current perspective, any movement away from unhealthy behaviors towards HL has significant health benefits. Moving from no physical activity to two 30-minute walks per week or replacing processed foods with two servings of fruits and vegetables per day, while not meeting ideal goals, significantly improves health outcomes.[17–19,22] For too long we have created a false and, for a large proportion of the population, unattainable *all or nothing* view of HL behaviors. If approached from the perspective that some HL behaviors are better than none and more is even better, we have a renewed opportunity to make significant progress in improving global trends in unhealthy lifestyles patterns and the resultant poor health trajectory.

As data from COVID-19 continues to evolve rapidly, one pattern is becoming clear - the presence of preexisting medical conditions, such as obesity, diabetes, hypertension and cardiovascular and respiratory diseases, significantly increase the risk of poor outcomes due to the viral infection.[24–27] Again, many of these preexisting medical conditions have also been described as pandemics and are listed in Table 1. Publications regarding the troubling interrelationships between COVID-19

Abbreviations and acronyms: SARS-CoV-2, severe acute respiratory syndrome coronavirus 2; NCDs, noncommunicable diseases; WHO, World Health Organization; HL, healthy living; CRF, cardiorespiratory fitness; HL-PIVOT, Healthy Living for Pandemic Event Protection.

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Table 1
Major health conditions described as pandemics.

Condition	Key Global Statistics From the World Health Organization
Overweight and obesity	• Global obesity has approximately tripled since 1975 • 39% (1.9 billion) of women and men who are 18 or older were classified as overweight in 2016 • The global prevalence of obesity (BMI ≥ 30 kg/m^2) was 13% (650 million) in adults and 18% (340 million) in children and adolescents (5–19 years) in 2016 • An estimated 40 million children under the age of 5 years are overweight or obese
Physical inactivity	• In 2016, 1 in 4 adults (1.4 billion people) and 3 in 4 children currently do not meet current physical activity recommendations • Physical inactivity in some countries are as high as 70%, attributed to changes in transportation, technology, and urbanization • The global cost of physical inactivity is estimated to be INT$ 54 billion in 2013 with an additional INT$ 14 billion attributed to lost productivity.
Diabetes	• Global prevalence has increased from 108 million (4.7% adults 18 years or older) in 1980 to 422 million (8.5% of adults 18 years or older) in 2014 • Approximately 1.6 million deaths were directly attributed to diabetes in 2016
Noncommunicable diseases	• Noncommunicable diseases kill 41 million people annually - 71% of all global deaths • 15 million people die from a noncommunicable disease each year who are between 30 and 69 years • Cardiovascular disease accounts for the most annual deaths – 17.9 million people – 31% of all deaths worldwide

and pre-existing medical conditions are already emerging. For instance, Dietz and Santos[25] discussed the increased hospitalization and mortality risk with H_1N_1 influenza infection in patients who are obese or severely obese, citing the impact significant excess body mass has on pulmonary function as one of the reasons for this association. Given the impact of COVID-19 on the pulmonary system as a primary manifestation and reason for hospitalization, concerns over the increased health risks for individuals who are obese is certainly justified. Moreover, individuals who are obese Fig. 1 present with other detrimental alterations relevant to the COVID-19 pandemic including: 1) A baseline increase in systemic inflammation that, when a viral infection is present, blunts macrophage activation and pro-inflammatory cytokine production with macrophage stimulation, contributing to compromised immune function; 2) increased viral shedding time (i.e., contagious for a longer period than normal weight individuals); 3) the potential for more virulent viral strains induced by the obese microenvironment; and 4) a positive correlation between body mass index and viral spread through exhaled breath.[24] These concerns are exponentially magnified given the global prevalence of excess body mass and obesity (Table 1). From the perspective of multimorbidity, Muniyappa and Gubbi[28] discussed COVID-19 in the context of patients with diabetes, drawing attention to the hypertension-obesity-diabetes triad that is common and the severe health risks (i.e., hospital admission, acute respiratory distress syndrome, mechanical ventilation, or death) with SARS-CoV-2 infection when an individual expresses this phenotype. Moreover, while the independent contribution of increased plasma glucose on increased risk following SARS-CoV-2 infection is unclear at this point, it has been shown to be a predictor of morbidity and mortality in those infected with SARS.[29] In recently reported findings from Wuhan China, Chen et al[27] found that older patients hospitalized with SARS-CoV-2 infection had a higher prevalence of comorbidities, greater symptom severity, and a higher likelihood of multi-organ involvement and mortality compared to younger patients. It has recently been estimated that ≈33% of the global population are affected by multimorbidity, particularly in those individuals who are 65 years or older.[30] In a recent CDC Monthly and Mortality Weekly Report,[26] the percentage of patients with SARS-CoV-2 infection and at least one pre-existing medical condition that required intensive care unit (ICU) admission (358 of 457, 78%) or hospitalization without ICU admission (732 of 1037, 71%) was significantly higher compared to those who were not hospitalized (1388 of 5143, 27%). Diabetes, as well as cardiovascular and chronic respiratory diseases, was the most reported pre-existing medical conditions. In >5000 patients admitted with SARS-CoV-2 infection to 12 New York (New York City, Long Island, and Westchester County) hospitals, Richardson et al[31] reported >90% had a pre-existing medical condition while 88% had two or more; the most common pre-existing conditions were hypertension (≈57%), obesity (≈42%), and diabetes (≈34%). These trends are disturbing in the context of the COVID-19 pandemic given the prevalence of the pre-existing health conditions listed in Table 1, indicating a large percentage of the global population present with a baseline health status that substantially increases the risk of hospitalization and poor health outcomes with SARS-CoV-2 infection.

Conversely, there is strong evidence base that indicates high cardiorespiratory fitness (CRF) as well as regular physical activity and a healthy diet improve immune function, affording protection against viral infections.[32–35] The COVID-19 pandemic, which has precipitated widespread shelter in place and social distancing policies, has also caused great concern regarding physical activity and exercise patterns.[36–39] The world was already largely physically inactive and sedentary pre COVID-19 and trends were not improving.[36] A reasonable question post-COVID-19 becomes will these trends in physical inactivity and sedentarism further accelerate, leading to a greater prevalence of the obesity, diabetes and NCD pandemics in the years to come? Initial evidence is emerging that indicates the answer to the first part of this question is *yes*. Zhang et al[40] recently reported a significant reduction in physical activity and a significant increase in screen time during the COVID-19 pandemic in >2400 children and adolescents in Shanghai, China. In >3000 adults in the United States, Meyer et al[41] found that, in people who were previously active, physical activity was reduced by ≈33% during the COVID-19 pandemic as well as a substantial increase in sedentary time regardless of pre-COVID-19 activity patterns. Decreased physical activity and increased sedentary time were both associated with worsening mental health. Interestingly, Irfan Ahmed[42] recently hypothesized that: 1) a measure of CRF, when available, may be valuable in risk stratifying individuals in the context of future viral pandemics; and 2) exercise training may serve a role in "preconditioning" individuals prior to viral infection. Both hypotheses should be investigated thoroughly and, if supported, would further bolster the importance of HL.

Like COVID-19, if we view the conditions listed in Table 1 as pandemics and we simultaneously recognize HL has profound benefits in preventing, mitigating and treating these pandemics, there becomes an opportunity to view a new global path forward for HL medicine. In this context, we would like to introduce the ***H**ealthy**L**iving for**P**andem**i**c E**v**ent Pr**ot**ection* (HL-PIVOT) network. The Merriam-Webster noun and verb definitions for *pivot* are "a person, thing, or factor having a major or central role, function, or effect" and "to turn on or as if on a pivot", respectively.[27] We feel these definitions support our choosing of the PIVOT acronym for the proposed new initiative: 1) the COVID-19 pandemic is playing the major role in impacting daily life patterns and how we perceive population health and; 2) this impact warrants turning or pivoting in a different direction with the goal of meaningfully increasing HL behaviors on a global level. The overarching goal of this network is to *promote human resilience and quality of life by increasing healthy living behaviors*. Table 2 lists areas of focus in knowledge discovery, education, policy, and implementation. We acknowledge that such a broad focus will require the network to consist of members from differing areas of expertise and interests. In this context, the American Heart Association,

Table 2
Major areas of focus for the HL-PIVOT Network.

Knowledge discovery	• Conduct healthy living research that furthers our understanding of the field and has real world applicability • Whenever possible, collaborate on research projects within the network to increase broad applicability and impact • Disseminate findings through peer-reviewed publications and conference presentations • Advocate for increased research funding for healthy living and collaboratively apply for funding within the network
Education	• K-12 and general college/university education: Promote and support initiatives that enhance students' understanding of the importance of healthy living and creates a culture of health and wellness • Health Professional Education: Promote and support the inclusion of healthy living medicine training in all health professional education programs
Policy Implementation	• Propose, support, and promote policies that increase the likelihood of healthy living behaviors on global, national, state, and local levels • Support and promote initiatives and messaging that creates a culture of health and wellness where individuals work, live, and go to school • Support and promote initiatives that increase the use of healthy living medicine in all aspects of health care delivery, moving from a reactionary care model to a proactive, preventive care model

Abbreviations: HL-PIVOT, **H**ealthy **L**iving for **P**andem**i**c **E**v**e**nt Pr**ot**ection.

European Society of Cardiology, European Association for Cardiovascular Prevention and Rehabilitation, and American College of Preventive Medicine jointly published a policy statement in 2015 entitled "Healthy Lifestyle Interventions to Combat Noncommunicable Disease: A Novel Nonhierarchical Connectivity Model for Key Stakeholders".[20] This policy statement took an *all hands on deck* approach to increase HL initiatives and behaviors. Fig 1 illustrates the central figure from this publication, identifying key stakeholders from multiple sectors who can work collaboratively to promote HL from a population to family/individual level. This policy statement, encouraging collaboration across multiple sectors in innovative ways, serves as a foundational framework for the HL-PIVOT network; any activity that promotes HL falls within the scope of the network. Admittedly, the novelty of HL-PIVOT is not to establish the importance that HL behaviors have on health trajectory; this premise is already beyond dispute. Rather, our hope is that HL-PIVOT becomes one of the important and lasting positive initiatives to emerge from the COVID-19 pandemic. Future goals regarding increasing HL behaviors and reducing the prevalence of unfavorable health conditions listed in Table 1 have been previously established; on our current trajectory we will not meet these goals.[28] A change in optics and a new approach for collaboration are primary driving forces for inception of the HL-PIVOT network. Healthy living has previously been described as a polypill that can come in many "shapes and sizes"[18] and still have tremendous benefits. Moreover, the HL polypill is an essential medicine for all the pandemics described in this commentary; no other medicine in the world can claim to have the same impact in treating multiple health conditions at the same time. Given the universal nature of HL medicine, working collaboratively, across professions in an unprecedented way, is warranted and perhaps the only way a meaningful impact on global health can be made at this point. Initially, founding HL-PIVOT network members will be encouraged to bring ongoing HL projects/initiatives under the HL-PIVOT umbrella. Subsequently, we intend to expand the HL-PIVOT network and continue to promote/facilitate collaboration and develop projects/initiatives in all areas listed in Table 2. It is our hope that a unified voice, promoting HL on a global scale, will greatly move the field forward and translate to meaningful improvements in HL behaviors and health outcomes.

In conclusion, the COVID-19 pandemic has caused a dramatic shift in how individuals live on a global scale. This change has dramatic implications for lifestyle behaviors (e.g., physical activity and nutrition), of which we will not understand the true lasting impact for some time. The COVID-19 pandemic also has the potential for valuable, long lasting lessons to be learned. Perhaps there is an opportunity to realize that we have been living in a world of *invisible pandemics* for some time now, specifically the obesity, physical inactivity, diabetes and NCD pandemics. Simultaneously, we are beginning to appreciate the relationship between the COVID-19 pandemic and pandemics that have been existing for years; those with obesity, diabetes or one or more NCD diagnoses who contract SARS-CoV-2 have a significantly higher risk for adverse health events. In this context, increasing HL behaviors across the lifespan, thereby building human resilience, can protect individuals from NCDs as well as a worsening health trajectory because of a viral infection. Now more than ever, HL is of paramount importance. Our hope is that the HL-PIVOT initiative brings this fact to the forefront and facilitates a new global path forward.

Appendix 1. Founding members of the HL-PIVOT Network

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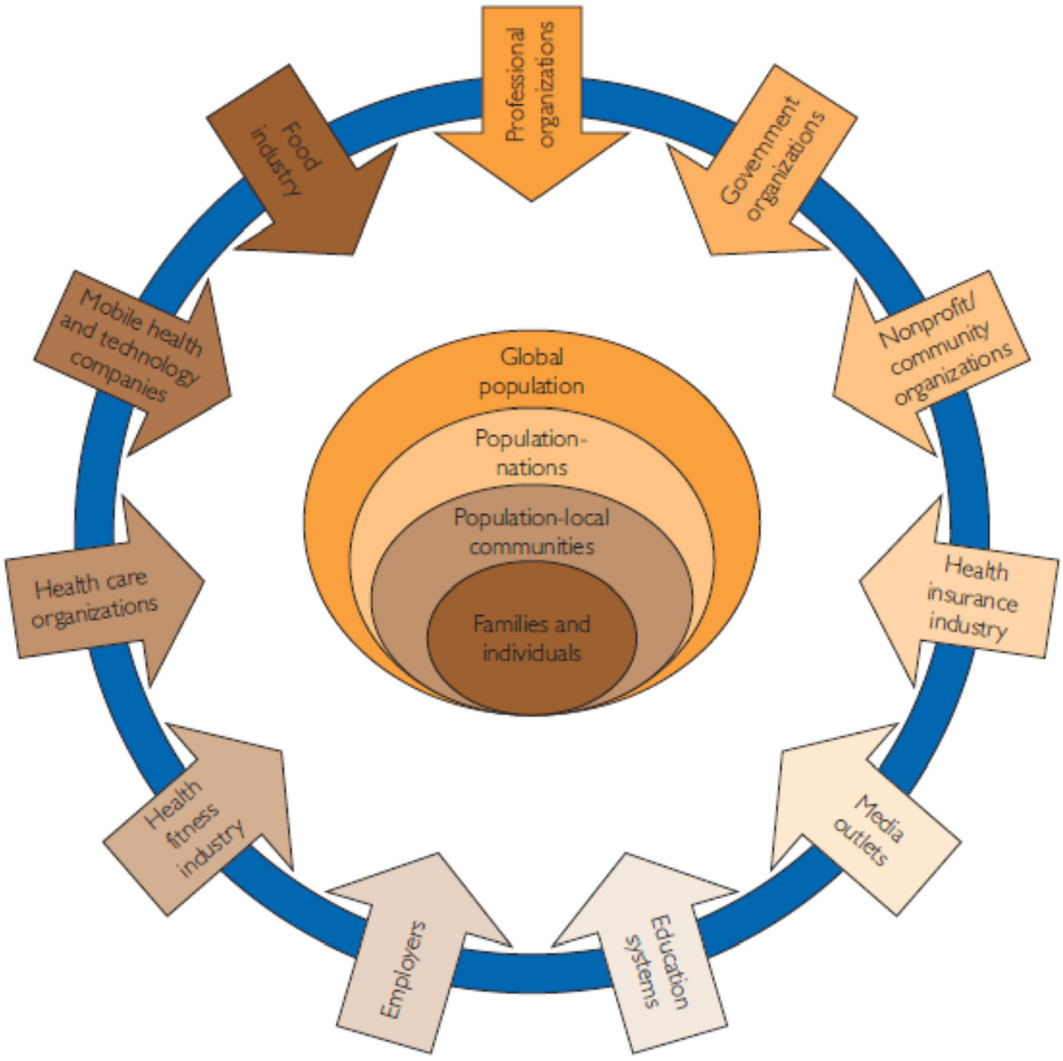

Fig 1. Conceptual model for a comprehensive approach to healthy lifestyle promotion, education and interventions.
With permission: Arena, R., et al. Healthy lifestyle interventions to combat noncommunicable disease-a novel nonhierarchical connectivity model for key stakeholders: a policy statement from the American Heart Association, European Society of Cardiology, European Association for Cardiovascular Prevention and Rehabilitation, and American College of Preventive Medicine. Mayo Clin Proc, 2015. 90(8): p. 1082–103.

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