Coronavirus and heatstroke at the Tokyo Olympic Games

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On the 12th of June, 2021 Christian Eriksen, midfielder for the Danish national soccer team, collapsed on the pitch during the Finland-Denmark match of Euro 2021. Afterwards, his team confirmed he experienced a cardiac arrest and required a defibrillator on the pitch. Although the exact underlying cause of this shocking event is not clear, it serves as a reminder that even the fittest athletes in the world can experience sudden, unexpected medical emergencies. The risk to athletes in the past year has been exacerbated by the novel coronavirus disease 2019 (COVID-19) pandemic, during which sports bodies and governments have attempted to keep professional sports competitions open, at some risk to players. For example, the start of the Japan Rugby Union competition for 2021, the Top League, was delayed due to multiple COVID-19 outbreaks, and several competitive combat sports events have been modified at the last minute or canceled due to COVID-19 infection among participants. These events are not necessarily safe for spectators, either: the 2020 Cheltenham festival was identified as a potential "super-spreader" event, as maybe was a prior international rugby match attended by the UK prime minister. Now, the perfect sporting super-spreader event looms: the 2020 Olympics, rescheduled to start in July 2021 in Tokyo, Japan. But this Olympics carries an additional risk beyond the obvious threat of coronavirus. Heat stroke, and the combination of extreme heat, humidity and the special demands of coronavirus prevention, may combine to create unique health risks for athletes and spectators alike at this Olympics.

We have been researching the effect of the COVID-19 pandemic in Tokyo, and also working on preparing infectious disease countermeasures for the Tokyo Olympics. In late 2020, as part of this research, we realised that the Tokyo Olympics faces a double burden of risk due to outbreaks of the novel coronavirus during the pandemic and heat stroke in both spectators and athletes. Together these risks offer a unique combination of challenges for the 2020 summer Olympics, and it is not clear if the Olympics organisers are ready to deal with them.

Heat illness, its impact on Tokyo health system and the Olympics.
A simple fact about Japan that is not widely appreciated outside of the archipelago is the extreme nature of its summer. Although short, the summer period in Japan from mid-July to mid-September is a period of extreme heat and humidity, which most non-Japanese cannot easily imagine. Temperatures in Tokyo in late July and early August routinely reach the mid-30s, with relative humidity in the 80s. Tokyo also has a ferocious heat island effect, which exacerbates the high summer temperatures, and due to its proximity to the ocean the heat does not subside at night. Because of this, public advisories about heatstroke prevention are ubiquitous in the summer months, and very few sporting events are scheduled in this period. It is the worst time of the year to hold elite competitive sports.

In general, the health risks of high temperatures are widely communicated with the public; however, humidity must also be taken into account, as high humidity can reduce heat loss, and negatively impact on the body's cooling mechanism. This makes it easier for people to develop heat illness. From this standpoint, the Wet Bulb Globe Temperature (WBGT) is commonly used in daily life as a combined measure of humidity and heat, and for considering re-scheduling or cancelling sporting events. The weekly average of daily maximum WBGT has increased dramatically in mid-August in recent years, from above 31°C to a maximum of 33.5°C. There is a direct relationship between high WBGT and emergency transportations for heatstroke, with the number of transportations increasing rapidly for every degree of WBGT over 30°C. This relationship can be seen in figure 1, which shows the cumulative total of emergency hospital admissions through different routes (left axis) and WBGT (right axis) during key weeks of the summer months for the past five years. As a result, emergency medical services face difficulties in timely delivery of patients to appropriate healthcare institutions between late July and late August.

The heat index in Tokyo is expected to be much higher than in previous competition venues of the Summer Olympic and Paralympic Games. A study

by our colleague Koji Wada showed that the mean WBGT in Tokyo during the period of the games reaches 34°C in the afternoon, with a range from 32 – 36°C, while the peak in Rio de Janeiro and Beijing was just 31°C. Furthermore, this peak is unrelenting: there is no point from midnight to midnight when WBGT falls below 30°C in Tokyo, and it is above 32°C for all sunlight hours. This will mean that Olympic athletes who have not yet adapted to the conditions will not perform properly. Furthermore, many groups with physical disabilities have a higher risk of heat-related illness, but no special health policy has been implemented for Paralympic sports. Given that many Olympic athletes are performing at the peak of human physical achievement, and many will not be used to the kind of temperatures they will experience in Tokyo, there is an increased risk to their health, and the possibility in some of the outdoor events of serious accidents. But our experience of COVID-19 in summer 2020 suggests that coronavirus counter-measures – in particular mask use and the need to ventilate indoor spaces – will worsen these already heightened risks. Our research, published in the International Journal of Environmental Research and Public Health in early 2021, showed that emergency admissions for heat stroke in summer 2020 may have worsened the challenges for emergency services dealing with coronavirus. These hospital admissions typically overwhelm emergency services, and some ambulances are forced to travel for long periods of time to find open emergency beds. We showed that in summer 2020, when Tokyo experienced a small wave of coronavirus infections, there was a peak in these delayed hospital admissions that was not consistent with the number of coronavirus infections, and was likely a consequence of the combination of many hospital beds being taken up with coronavirus patients at the same time as the sudden surge in heat stroke cases. This pattern is shown in Figure 2, which plots the daily case numbers of COVID-19 (left axis) and the number of daily emergency transportations which failed to find a reception hospital within a defined time period (right axis).

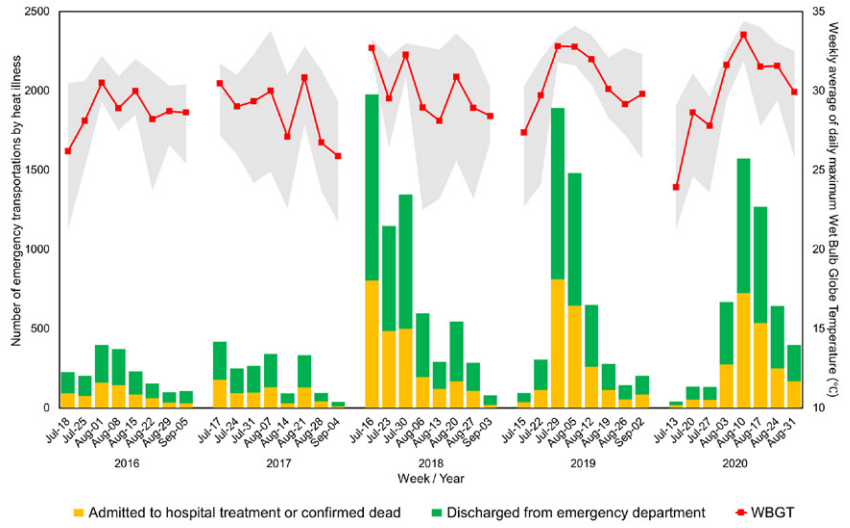

Figure 1: Average Tokyo WBGT and distribution (right axis) and combined emergency hospital admissions for heat stroke (left axis) during key summer months in Tokyo, 2016 – 2020.

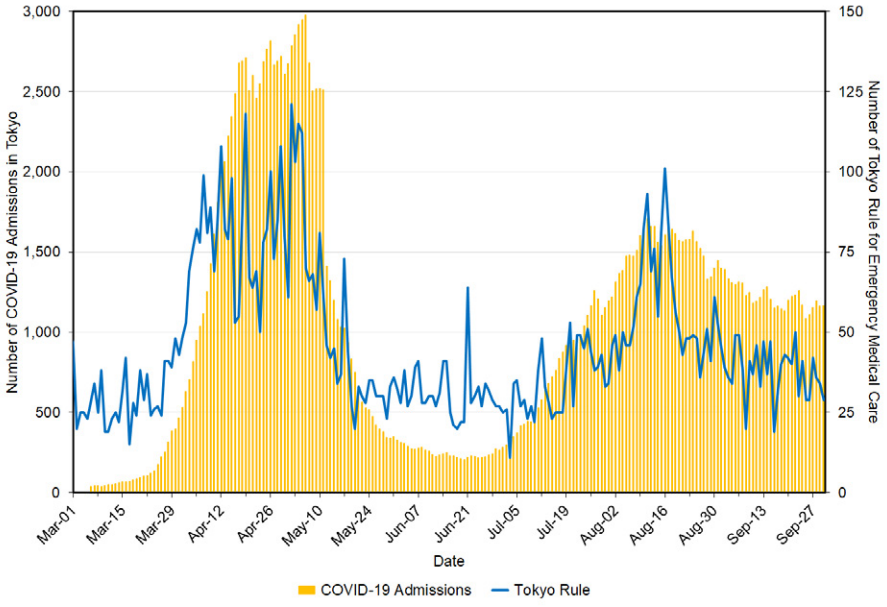

Figure 2: Daily COVID-19 cases (left axis) and emergency transportations that did not find a hospital within a defined time period (right axis) in Tokyo, March – September 2020.

Although daily cases in Japan at present are not especially high, with Tokyo seeing between 300 and 700 new COVID-19 cases every day, we are currently under a state of emergency that is expected to end on 20th June, and it is likely that by the start of the Olympics Tokyo will be experiencing a new wave of COVID-19 cases. Moreover, COVID-19 clusters caused by several variants of concern have been reported, and many of their related cases have become untraceable. With the onset of the summer heat this could cause the same sudden

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surge of hospital admissions, blocked beds, delayed emergency admissions and health system pressure that was seen in summer 2020 – only this time it will be exacerbated by the presence of a large number of foreign visitors who are at high risk of heat stroke and do not understand Japan's summer weather or its health system.

COVID-19, its impact on the Tokyo health system and the Olympics. Compared to other high-income countries, Japan has so far mitigated the worst epidemiological impact of COVID-19. Despite the fact the ongoing transmission of COVID-19 in Japan has been classified as "clusters of cases", around 50% of contacts cannot be traced in Tokyo, suggesting the presence of some untraced community transmission. Furthermore, Japan has lagged in COVID-19 vaccination rates compared to other high-income countries. While the vaccination program first started in mid-February, only 15% of the population (mainly health workers and people aged 65 and over) had been vaccinated by early June.

The International Olympic Committee (IOC), International Paralympic Committee (IPC), Tokyo 2020 Organising Committee (Tokyo 2020), the Tokyo Metropolitan Government (TMG) and the Government of Japan have developed a range of measures to enable the Games safely in the context of COVID-19. They also said that 80% of the Village would be vaccinated, and some countries prioritise vaccination of athletes ahead of the Olympic Games Tokyo 2020. Nonetheless, there are multiple risks surrounding the Olympic and Paralympic games, connected to both Tokyo's unprecedented heat and the unusual coronavirus situation. Although many athletes are very fit and young and unlikely to experience significant ill-effects of coronavirus infection, an outbreak of COVID-19 among athletes at their accommodation remains a significant risk. This will have particular risk for some athletes who may be clinically overweight (for example, heavyweight fighters and weight lifters), who may be dieting to cut weight (for combat sports or other events with weight classes) or who are older (for example shooters and equestrian athletes) and at greater risk from viral infection. In addition to the risk to the athletes' health, such outbreaks may also lead to the interruption and/or cancellation of events, and the possibility that the Olympics could become a global super-spreader event as athletes and support staff from over a hundred nations return to their home countries.

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For many athletes, strict COVID-19 countermeasures will require that they wear masks in public and at sporting venues, while waiting between events and in waiting areas for events. A key component of Japan's relatively successful countermeasures against COVID-19 has been action against the "three Cs": closed, crowded and close-contact settings. To be consistent with these counter-measures, event venues will be generally ventilated with free movement of air from outside, which will reduce the effectiveness of air conditioning and increase interior temperatures, preventing sportspeople from gaining the respite they might need to lower body temperatures. Of course, close environments will be necessary for several competitions like badminton and table tennis, which potentially have higher risks of COVID-19 transmission and could trigger super-spreading events. Many athletes in track and field, equestrian, boating, shooting, archery and other semi-outdoor and outdoor events may have to spend long periods of time waiting in high-temperature locations wearing masks, possibly in direct sunlight, when daytime WBGT values will lie in the extreme range. This will increase the risk of both minor heatstroke events and major incidents with potentially life-threatening consequences for some athletes. At the same time, a renewed wave of coronavirus infections in the general community will put pressure on the health system, leading to the same delays in emergency response that were observed in Tokyo in 2020, but exacerbated by the sudden demand placed on the system by heat stroke among Olympic participants, support staff and spectators.

However, it is also important to discuss whether prioritising vaccination for the Olympic and Paralympic Games participants is truly fair and ethical, as rich countries dominate vaccine supplies and many essential workers, even healthcare workers, in low-and middle-income countries are still facing challenges to be fully vaccinated. The 2021 Olympics presents the spectacle of rich countries hoarding vaccines to protect elite athletes from coronavirus exposure in an event the majority of Japanese citizens think should be cancelled, only to create a super-spreader event that inflicts new waves of the pandemic on countries that are unable to access those same vaccines. This is the perfect example

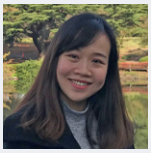
of sport acting as a mirror for global society's ills, and there is little evidence that the Olympics organisers have any interest in addressing this issue.

Olympics from the perspectives of public health systems and services. The peak of emergency transportations due to heat illness overlapped the resurgence of COVID-19 in 2020, and an increase of heat illness patients with rising WBGT has been observed. Without urgent reconsiderations and sufficient countermeasures, the double burden of COVID-19 and heat-related illnesses in Tokyo will overwhelm the healthcare provision system and maintaining essential health services will be challenging during the 2020 summer Olympic and Paralympic Games. Our research provides clear evidence that emergency medical services faced difficulties in delivering patients to appropriate healthcare institutions and early intervention in July and August 2020 in Japan, and there is every risk that the same conditions which caused those health system burdens in 2020 will be repeated or even worse in 2021. This summer's Olympics are still underprepared for safely organising the games in the context of both COVID-19 and heat policy. Considering the ongoing COVID-19 pandemic and Japan's overwhelmed public health systems, securing sufficient surge capacity for the games, such as resources for regular COVID-19 screening and isolation facilities in multiple venues where the games are scheduled, will be an imminent challenge. People watching the games at home should remember the extreme heat stroke risk that the athletes are facing, as well as the background risk of coronavirus spread in Tokyo. These games are not popular in Japan, and the callous disregard that the international organisers have shown for both the athletes and the citizens of Tokyo should not be forgotten as the spectacle unfolds.

About the Authors

Stuart Gilmour is professor of biostatistics and bioinformatics at the Graduate School of Public Health, St. Luke's International University, Japan. Stuart was born in New Zealand and raised in Australia by British parents, and has lived in Japan since 2006. He originally studied physics but shifted careers to public health where he began his career researching the health of marginalized populations, especially sex workers and people who inject drugs. Stuart obtained his undergraduate degree in mathematical physics at the University of Adelaide, completed masters in Public Health at the University of Sydney, a Masters in Statistics at the University of New South Wales and his PhD at the University of Tokyo. His research interest is in quantitative health system assessment, the use of statistics to improve our understanding of policies and interventions that can improve population health, especially where it is affected by inequality and exclusion.

Kazuki Shimizu A cosmopolitan-minded physician and scientist of global public health. His expertise ranges across critical topics in global health, such as infectious disease epidemiology, health emergency preparedness and response, global health security, health system financing, and public private partnerships. At London School of Economics, he was mainly involved in "The Lockdown" survey, a global initiative to capture the experience of social distancing policy and assess how the measures taken to fight against the COVID-19 pandemic affected the educational process, professional opportunities, and wellbeing. Previously, he was trained as a physician and completed his medical residency at the Medical Support Division, Toyota Motor Corporation. He also completed his externship at University of Florida Health Shands Hospital. He obtained his M.D. at Nagoya University, Japan, and earned M.Sc. from London School of Economics and Political Science and London School of Hygiene and Tropical Medicine, United Kingdom. He is a certified physician in the Japanese Society of Travel and Health and holds a position as adjunct lecturer at Nagoya University Graduate School of Medicine, Japan.



Phuong Mai Le is a Vietnamese researcher who has been living in Japan for 3 years. She completed a Masters of International Health in the Netherlands in 2016, and has rich experience in the HIV/AIDS response, with eight years working in the Vietnam Ministry of Health. Le presently works as a research assistant at the Graduate School of Public Health, St. Luke's International University in Japan. She has published articles related to the healthcare system, HIV/AIDS, and global health issues. Her research interests focus on promoting the health of vulnerable populations, such as ethnic minorities, particularly women and children.