

## Is sweat a possible route of transmission of SARS-CoV-2?

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### Abstract

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) has caused a global pandemic, in part due to the highly infectious nature of the disease. Because SARS-CoV-2 is new, much is unknown regarding mechanisms of transmission, and such information is urgently needed. Here, based on previous findings from related human betacoronaviruses, it is suggested that one possible route of transmission may be via infectious sweat. It is suggested that research be conducted in order to determine whether sweat in SARS-CoV-2 infected individuals harbors virus in quantities that can infect others. Findings could be used for formulations of mitigation strategies and empirically based public health messaging.

**Keywords:** SARS-CoV-2, COVID, sweat, transmission, transmissibility, comment

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Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a highly transmissible betacoronavirus that has been declared as a global pandemic by the World Health Organization,<sup>1</sup> with a possible overall fatality rate of ~6%.<sup>2</sup> SARS-CoV-2 is one of the several known human betacoronaviruses, with that genus also including Middle East respiratory syndrome (MERS) and severe acute respiratory syndrome coronavirus (SARS-CoV), the latter two of which may be more lethal, but less infectious, than SARS-CoV-2.<sup>2</sup> Symptoms of SARS-CoV-2, MERS, and SARS-CoV are highly overlapping, and results of studies suggest that they are similar in biological mechanism.<sup>2</sup> Given that SARS-CoV-2 is a novel coronavirus in the same group as the more studied SARS and MERS, it may be useful to extrapolate from those viruses to SARS-CoV-2 regarding viral behavior. Therefore, using findings from SARS and MERS, the purpose of this correspondence is to highlight an under-considered potential mechanism of transmission of SARS-CoV-2, that being by sweat.

Surprisingly, very little research has been done examining the potential role of sweat in the transmission of any betacoronavirus, especially given that other lethal viruses may be contagious via sweat.<sup>3</sup> SARS-CoV has been found in the sweat glands of deceased SARS-CoV victims,<sup>4</sup> indicating possible transmission of SARS-CoV from the skin via sweat. A case of a healthcare worker who became infected with MERS during cardiopulmonary resuscitation suggests that MERS too may be sweat-born.<sup>5</sup> Although not definitive, it was determined that one potential route of

contamination may have been via the patient's infected sweat touching the mucosal membrane of the healthcare worker's mouth.

Interestingly, in 212 SARS-CoV-2 diagnosed individuals, 114 (53%) reported "profuse sweating" and 102 of these reported "night sweats" as well.<sup>6</sup> These findings suggest ample material for infection, if sweat does indeed contain infectious SARS-CoV-2. Given that other betacoronaviruses may (i) be found in sweat glands<sup>4</sup> and (ii) be transmissible via sweat<sup>5</sup>; and given (iii) the high degree of "profuse sweating" reported in SARS-CoV-2<sup>6</sup>; and (iv) the highly transmissible nature of SARS-CoV-2,<sup>7</sup> it may be that one underestimated mode of transmission of SARS-CoV-2 is from contact with sweat of an infected individual.

In addition to impacting recommendations for the general population, this possibility has particular implication for household members caring for infected individuals who may currently be unaware of this potential route of infection, and that have demonstrated a high secondary attack rate, particularly between spouses.<sup>8</sup>

Transmission via sweat might occur via skin-to-mucosa contact (as may have occurred in the healthcare worker infected with MERS<sup>5</sup>); theoretically, transmission may also occur via skin-to-object-to-mucosa contact. For example, in the same manner virus may be deposited on an object via coughing, it may be that infected sweat can be residually left on objects, which are subsequently touched by other, non-infected individuals, who then become infected. Recent work demonstrating the relatively lengthy

time SARS-CoV-2 can remain viable on surfaces<sup>9</sup> suggests that this route of transmission may, at least in theory, be possible.

Of additional note, the receptor by which SARS-CoV-2 obtains entry into the human cell is human angiotensin-converting enzyme 2 (ACE2),<sup>10</sup> and it is thought that organs containing high ACE2 enable more viral entry, and therefore higher likelihood of infection and illness. ACE2 is itself found in the skin, smooth muscles surrounding sebaceous glands as well as within these glands, and eccrine glands.<sup>11</sup> These findings raise the disturbing possibility that the high proportion of ACE2 receptors in skin and skin glands can allow for the absorption of SARS-CoV-2 through the skin itself, resulting in infection. In this scenario, inhalation or the touching of mucosa would not be needed for infection to occur. Instead, the simple handling of sweat-soaked sheets, for example, could provide opportunity for infection.

While masks may reduce the likelihood of infection via droplet-encased virus particles, bedding and clothing contaminated with the potentially infected sweat of sick family members has not been ruled out as a means of SARS-CoV-2 transmission within a household, and transmission via sweat may help to account for the high transmission rate found between spouses.<sup>8</sup> Additionally, as the Northern hemisphere enters summer, a period associated with higher temperatures and therefore increased sweating, potential increased opportunities for outbreaks exist. Finally, in many countries gyms and other physical health venues are being opened; care needs to be taken to ensure sweat-borne transmission does not contribute to infections.

Questions certainly remain about sweat as a potential route of transmission (as well as whether skin absorption can occur) including whether SARS-CoV-2 can be detected on the skin or in sweat in symptomatic or asymptomatic individuals, and whether SARS-CoV-2 infected individuals shed virus in quantities in sweat to be infectious.

Based on the minimal previous research on the viruses closest to SARS-CoV-2, it is recommended that sweat as a possible route of transmission for SARS-CoV-2 be investigated. Given that ACE2, the entry point for SARS-CoV-2 into human cells, is relatively abundant in the skin, additional work should examine whether skin absorption of SARS-CoV-2 occurs, and whether such absorption can cause infection. Together, such investigations will enable either the ruling out of sweat, or absorption through skin, as methods of transmission, or will allow for formulations of mitigation strategies and appropriate public health messaging.

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