

# A Helmet Type Mask “Distancing-Free Mask” An Engineering Solution that Eliminates the Lockdown

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**Keywords:** corona, lockdown, social distancing, COVID-19, SARS CoV 2, new normal, collective immunity, basic reproduction number,

**Abstract.** As a solution to eliminate the lockdown and to guarantee the implementation of the Tokyo Olympic Games, we developed "Distancing-Free Mask" prototype and propose new social infrastructure and lifestyles. This mask simultaneously achieves the four items, (1) full virus shield, (2) lightweight body, (3) easy breathing, and (4) inexpensive manufacturing costs, at a high level by precise control of pressure and flow rate inside the helmet. The wearer of this mask, just like the antibody carrier, cannot be infected itself with the virus, nor infect others with the virus. Currently, a combination of "new normal" and "Lockdown (= outing control, behavior control, business control, economic regulation)" is being taken around the world. Since there is no prospect of developing a vaccine or treatment method, there is no prospect of leaving the current situation. Distributing the "Distancing-Free Mask" to each citizen means having a simple and reliable means of converging the infection. Even under the worst infection spread situation, people can go out as long as they wear "Distancing-Free Mask". Organizers of events such as the Tokyo Olympics need only take measures in anticipation of situations where masks are mandatory.

## 1. Introduction

The new coronavirus is expected to continue mutations and remain on the earth. The greatest threat is that the virus might be more virulent and more infectious due to mutation than the current virus threat, and it is not known when such more virulent and more infectious virus will emerge. Society in the future will always be required to be prepared for the emergence of vicious viruses due to such mutations. In the future society, it is expected that the social aspect will be changed on the premise of keeping a social distance. Telework, online classes, etc. will become popular as standard. However, people need/want to participate in various events (Tokyo Olympics, ceremonial occasions, festivals, concerts, sports games, theaters, etc.), face-to-face meetings at companies and government offices, experiments and practical training at schools and universities, etc. It is expected that the demands for the physical movement and assembly of the will definitely remain.

Currently, Japan and other parts of the world are experiencing intermittent lockdown as a countermeasure against new coronavirus (SARS CoV 2) infection. There are 4 possible scenarios to get out of the locked-down intermittent state. [1-3] "Lockdown" here is defined as "a state in which the government requests or orders some kind of going-out regulation, business regulation, or behavior regulation as a countermeasure against infection." Japan is now under a weak lockdown.

[A] Most of the people have become infected and have acquired immunity, and acquired collective immunity.

Collective immunity is acquired when most of the people have become infected and have been cured and acquired immunity. Here, the important point is that the "mask wearer" cannot be infected by the virus nor infect the virus to others, so from the viewpoint of collective immunity, it is equivalent to the "immunity acquirer".

[B] A "prophylaxis (vaccine)" has been developed, and vaccination will obtain collective immunity.

If a "prophylaxis (vaccine)" is developed, as with influenza, the majority of non-infected persons will be vaccinated to obtain collective immunity.

[C] An "effective therapeutic agent" is developed.

Once "effective remedies" have been developed, made available, and are able to heal infected individuals easily, there is no need to fear the spread of infection.

[D] A "simple and reliable test method" is developed.

If there is a "simple and reliable test method/tester" just like a thermometer or a blood pressure monitor, it is enough to promptly detect the infected person, isolate and treat it. Others (=confirmed to be non-infected people) do not need to keep staying at home at all. Since there is no "easy and reliable test method" available now, the whole society will be placed in the darkness where no one knows who is infected, and everyone can only respond uniformly.

Among the above-mentioned escape scenarios, [A] Collective immunity acquisition is difficult to adopt in Japan because of the large cost. In addition, if any of [B] preventive method (vaccine), [C] therapeutic agent, and [D] simple and reliable test method are developed, the problem will be solved, but any of them is expected to be developed immediately. (It is expected that it will take at least one year at the shortest.) In other words, until this current invention/proposal is made, it has been "occlusion in all directions".

Since the "percentage of people wearing this mask" is equivalent to the "percentage of people who have immunity (antibody) in the population," increasing the proportion of people wearing this mask will lead to the same effect as the acquisition of collective immunity!

Building a social infrastructure using "Distancing-Free Mask" is the only way to immediately eliminate the need for lockdown and to overcome corona crisis.

## 2. Features of "Distancing-Free Mask" [4]

Figure 1 shows a schematic diagram of the helmet part. Figure 2 shows the mechanism of air supply and exhaust of purified air in this mask consisting of a helmet part and a backpack part. The features of the present invention are the following three points.

[1] By controlling the inside of the helmet to a slight positive pressure, it is possible to completely block the entry of outside air from the seal part of the neck. In addition, the helmet dome can be made of a lightweight transparent resin material by keeping the internal pressure high to some extent. Invasion of virus can be blocked 100%. The virus emission depends on the air tightness of the neck seal, but it can be suppressed at a high level.

[2] A constant flow of air is taken in and out to keep a fresh air flow in the helmet. This allows fresh air to be breathed without adding extra load to the lungs.

[3] A high-performance filter with extremely large flow resistance can be inserted by forced air supply and exhaust by a pump, pressure buffer, and electromagnetic control valve housed in a backpack. It is also possible to equip the air supply side and the exhaust side with virus killing devices (UV irradiator, plasma cluster generator, etc.).

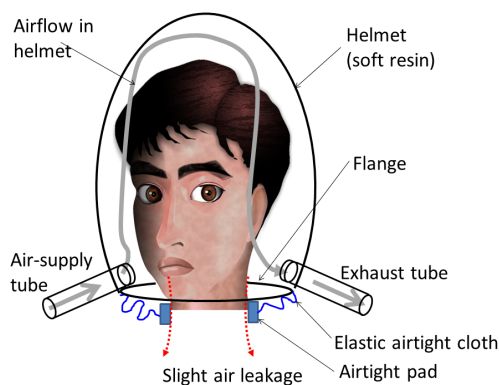


Fig. 1. Airtight helmet part of “Distancing-Free Mask”.

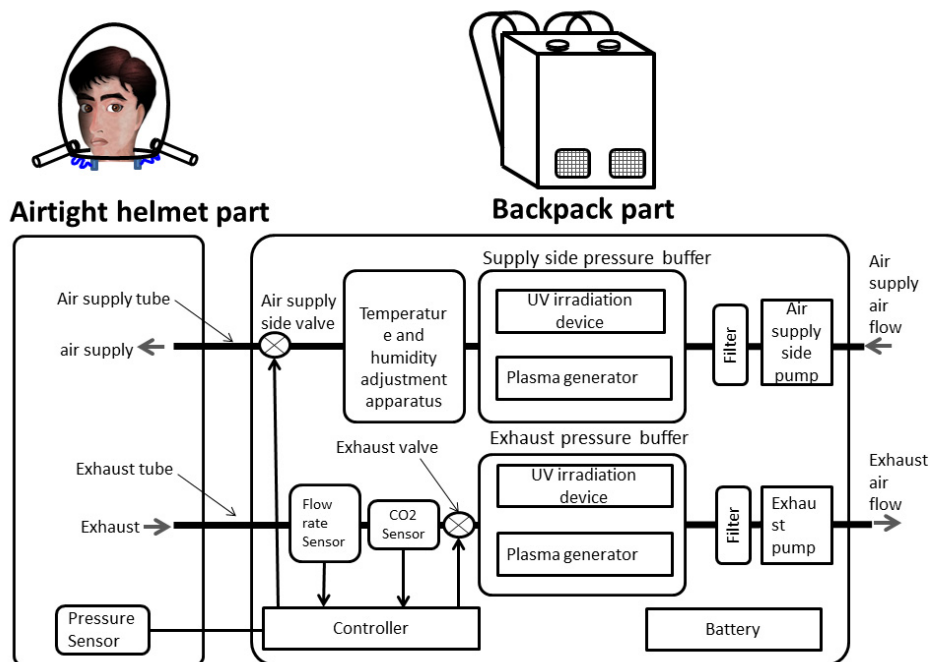


Fig. 2. Mechanism of air supply and exhaust of purified air.

Figure 3 shows the photo of the first prototype of “Distancing-Free Mask”.



Fig. 3. Photo of the 1<sup>st</sup> prototype of “Distancing-Free Mask”

### 3. Acquisition of Collective Immunity by “Distancing-Free Mask” [5-8]

The collective immunity rate  $P_c$  required to obtain the collective immunity can be expressed by the following equation using the basic reproduction number  $R_0$ .

$$P_c = 1 - 1/R_0$$

Example: When  $R_0=5$ , the infection ratio  $P_c=1-1/5=0.8$  (80%) required for collective immunity acquisition.

The basic reproduction number  $R_0$  can be expressed by the following equation.

$$R_0 = \beta \times k \times D$$

$\beta$ : Probability of infection per contact

$k$ : Average number of times one person contacts another person in the group per unit time

$D$ : Average infection period

The basic reproduction number  $R_0$  is defined as the average number of people who are infected by an infectious disease and are directly infected during the infection period when they join a group (society) in which no one is immune. From the definition, in the “state where there are almost no infected people”, if  $R_0=1$  for the group (society), it is a steady state, if  $R_0<1$ , it converges, and if  $R_0>1$ , it expands.  $R_0$  depends not only on the nature of the virus, but also on the nature of the population (racial constitution, condition, public health condition, individual health condition, etc.). It is thought that  $R_0$  can be reduced against all viruses by improving public health.

That is, the following is valid.

**Reduction of  $\beta$ :** Immunity increased, mask worn, hand washing encouraged.

**Reduction of  $k$ :** Working from home, introducing home-based learning, and ensuring social distance.

By creating a social state in which  $\beta$  and  $k$  are reduced,  $R_0$  is reduced and  $P_c$  is reduced.

It can be said that the lockdown state is a state in which  $\beta$  and  $k$  are extremely reduced.

An uninfected person wearing a "mask that can completely shield the virus" he does not infect the virus or infect others with the virus, as does a cured immune carrier. Therefore, the ratio of "wearers with Distance-Free Mask" can be considered to be equivalent to the above collective immunity rate  $P_c$ .

$$MR = 1 - 1/R_0$$

Figure 4 shows the relationship between **MR** and **R0**.

Shows

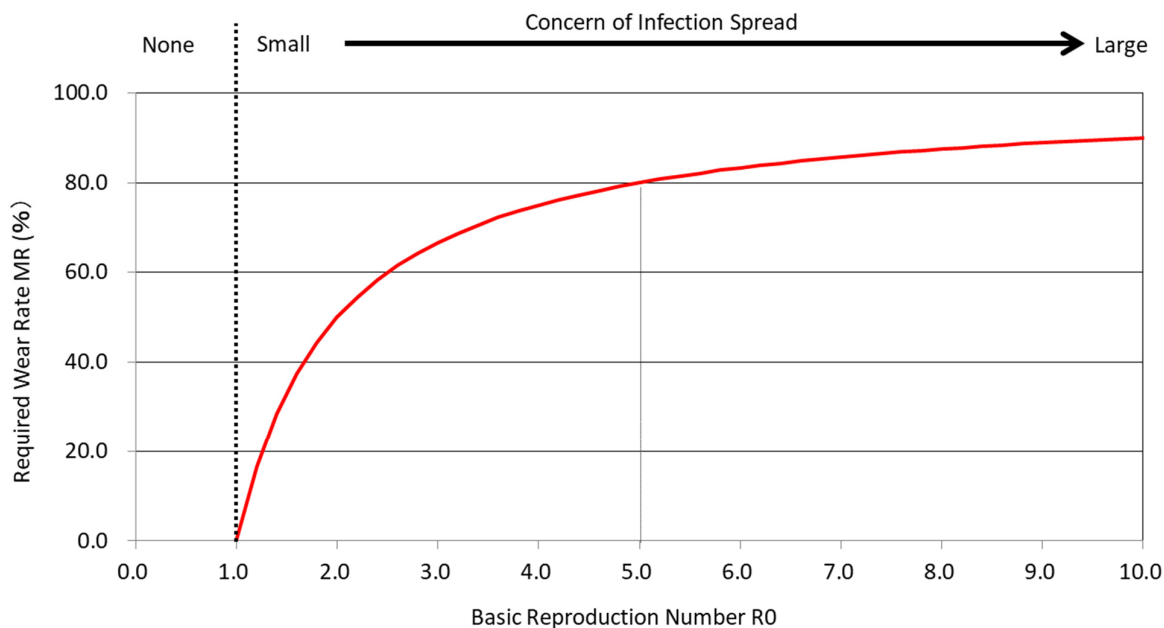


Fig. 4. Relationship between **MR** and **R0**

For example, if the number of basic reproductions of the virus in society is  $R_0=5$ , it can be read from Figure 4 that the required wear rate is  $MR=80\%$ . In other words, all citizens should wear the mask 80% or more in the total numbers of contacts. (It is unnecessary to wear the mask 100% in order to make the infection converge in the whole society.)

The "wearer of Distancing-Free Mask" has an "infinite social distance" to the people around it. (It takes an infinite social distance regardless of the physical distance.) A nation (society), in which all the people have one "Distancing-Free Mask" and wear it when they go out, is extremely resistant to viruses.

#### 4. Social States of the Corona Era

We predict the social aspects/states of the corona era to be as follows.

[1] All people have one "Distancing-Free Mask".

[2] If there is a risk of spreading the virus, the government will declare an emergency and oblige the people to wear "mask" when going out.

\* If a person wears "mask", he/she can go out freely without any restrictions.

\* For example, if 80% of people wear "mask" when going out, it is equivalent to achieving 80% of the collective immunity.

[3] When it is confirmed that the virus infection has been resolved, the government lifts the

declaration of emergency and ceases to be obligated to wear a "mask" when going out.

Unlike primitive people, modern people drink "purified water" rather than "water from rivers and puddles." "Air" contains various pollutants such as viruses, PM2.5, pollen and dust. Therefore, in the near future, it is expected that there will be a strong demand for breathing "purified air" instead of "natural air". In the near future, many people will wear "Distancing-Free Mask" when going out, regardless of the spread of virus infection and whether or not there is a request from the government to wear it.

People wear "shoes" when they go out. Similarly, in the near future, people will wear "mask" when going out. Then, it is expected that people will own various types of "masks" in the same way as they own various types of "shoes".

### 5. Conclusions

We believe that the "mask" based on the present invention and its peripheral systems (provision of service air supply/exhaust ports in vehicles and facilities, home airlock systems, etc.) will become an indispensable social foundation in the corona era.

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