



Projections of Demand and Estimates of Global Production of Personal Protective Equipment (PPE) Equipment

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Question

- *What are the current projections of demand for different PPE products, including for example masks, respirators, gowns, gloves etc?*
- *What are the latest estimates of global production of PPE?*
 - *Where possible, provide a geographic breakdown*

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1. Summary

This report focusses on the global supply and demand for Personal Protective Equipment (PPE) during the COVID-19 pandemic. The report includes current production of PPE and projections of demand over the next few years.

Findings from this review shows that the demand for PPE in the context of the current COVID-19 pandemic far outstrips supply and that there is a huge need for escalating global production as COVID-19 evolves and has spread across the world.

The literature for this review was mainly from grey sources, including: published news articles, market research reports and blogs. Published academic literature was also utilised but to a limited extent due to the pandemic's current and evolving nature.

The following key points emerge from this review:

- Global demand for PPEs and medical devices was booming before the onset of COVID-19, because of aging populations particularly in high and middle-income countries. This demand has surged due to the COVID-19 pandemic (Gereffi, 2020).
- Exports of PPEs have increased by 45% between 2008 and 2018 amongst traditional suppliers, and over the same time period, this has increased by 100% among non-traditional producers in middle income countries (Bamber et.al., 2020).
- Single-use surgical face masks including N95 masks that filter very small particles such as COVID-19 virus particles is one piece of PPE equipment where demand far outstrips supply globally. For example, the US Department of Health and Human Services estimates that the United States will have to increase its monthly production from an 80 million masks to 290 million masks per month (Hufford, 2020).
- China is the largest producer of PPE, supplying 50% of surgical masks globally. Countries in South East Asia such as Malaysia, Thailand and Taiwan are also dominant producers of PPEs including surgical and rubber gloves; masks and non-woven protective garments (OECD, May 2020).
- Global demand for PPEs and medical devices has led to globally diverse interconnected supply chains (Bamber et.al, 2020).
- More complex PPEs are produced by traditional suppliers in high income countries whereas PPEs with more basic technologies are produced by middle income countries (non-traditional suppliers) (Bamber et.al, 2020).
- Supply chains will need to be further improved to ensure supply meets global demand (UNICEF, 2020; International Finance Corporation, 2020).
- Local solutions are being found in the developing world to increase supply of PPE through textile manufacturing companies retooling to supply basic PPE (Dalberg Advisers, 2020; Maylie, 2020).
- To successfully manage subsequent waves of COVID-19 and future new pandemics, PPE production and supply needs to be globally sustainable. Physical or virtual stockpiling are methods to be considered to ensure the sustainability of PPE supply. Examples of this have been modelled in Canada, the USA and other countries (Kaliya-Perumal, et.al., 2020).

2. Supply and Demand for Personal Protective Equipment (PPE)

Supply of PPE

Factories located in the People's Republic of China (PRC) are the biggest suppliers of PPE. This includes many of the raw materials that constitute finished PPE products. China produced an estimated 50 per cent of surgical masks globally (prior to the pandemic the country produced an estimated 20 million masks a day). Taiwan also has a significant market share in the global supply of face masks. Other countries that produce PPE include India, Japan, Korea, Malaysia, Mexico, Thailand, United States (US), and several European countries. China reportedly boosted the production of masks more than five-fold earlier this year, providing a daily production capacity of 110 million units and has likely increased production further since that time (UNICEF, 2020).

The supply of PPE is illustrated in Figure 1 and highlights country shares in the exports of PPE. Trade in PPE devices has more than doubled over the period 2008-2018 and this has been attributed to a rapidly aging population in high and middle-income countries (Gereffi, p. 290, 2020).

See: Figure 1: Top Exporters of selected COVID-19 goods, 2018, Source: OECD (2020, p.5), https://read.oecd-ilibrary.org/view/?ref=132_132706-m5stc83l59&title=Policy-Response-Trade-Interdependencies-in-Covid19-Goods

Bamber et.al (2020) note that exports from traditional locations (for example: Belgium, Canada, France and Germany) have increased by 45% since 2008 (Figure 2). However, PPE such as face masks, gowns and gloves are produced predominantly by non-traditional exporters and have grown twice as fast (by 100%) (Bamber et.al., p.2, 2020). Figure 3 highlights the diversification of exporters of PPE and medical devices and the Compound Growth Rate (CAGR) shows that many non-traditional exporters have grown faster in the manufacturing of both medical devices and PPE materials.

See: Figure 2: Exports of Medical Supplies and Devices, 2008 and 2018, Source: Bamber, Fernandez-Stark, and Taglioni (2020). Using UN Comtrade Database. Based on import data as of 16 April 2020, <https://blogs.worldbank.org/developmenttalk/four-reasons-why-globalized-production-helps-meet-demand-spikes-case-medical>

See: Figure 3: Traditional and non-traditional PPE and medical device exporters, 2008-2018, Source: Bamber, Fernandez-Stark, and Taglioni (2020). Using UN Comtrade Database, <https://blogs.worldbank.org/developmenttalk/four-reasons-why-globalized-production-helps-meet-demand-spikes-case-medical>

Reasons for the global diversification of production of PPEs and medical devices can be attributed to a number of factors, summarised by Bamber et.al. (p. 1-3,2020):

- **Booming global demand:** has seen traditional exporters substantially increasing exports and non-traditional producers increasing production even more.
- **Although global production has increased, outsourcing in the sector has been slow with leading firms in developed countries dominating global supply:** this is attributed to the vertical integration¹ of leading companies and their ability to develop global platforms to enable them to access new demand in emerging markets. They are also able to mitigate risk through making use of supply chain complementarities and strengths in different regions.
- **COVID-19 has increased the demand for PPE: this has** been offset by global supply chains that have lessened equipment shortages in countries where COVID-19 has had the most severe impact. In addition, countries have been able to rapidly find alternative sources of supply from non-traditional exporters such as the importation of gloves from Sri Lanka and Thailand and hospital gowns from the Dominican Republic, Honduras and Vietnam.
- **The huge scale-up of supply during COVID-19 posed production and processing challenges. Relationships between companies facilitated the sharing of knowledge and strengthened the coordination in the production of PPE.** Although many companies have dramatically increased their production, many cannot keep up with demand and therefore partnerships between firms have been created to expand production and introduce new innovations in production and processing equipment.

With respect to demand for PPE, UNICEF (2020) notes that there will be a large gap between what UNICEF and its partners can supply in terms of demand requirements for lower and middle-income countries. It estimates that up to 2.2 billion surgical masks, 1.1 billion gloves; 13 million goggles and 8.8 million face shields will be needed. The surge in demand for specific PPE items has inflated prices, and worsened UNICEF's ability to procure PPE for lower income countries because of high income countries' (European governments and the United States of America (US) willingness to pay elevated prices for limited PPE supplies (UNICEF, 2020). The rapid increase in demand has also put pressure on the supply of raw materials specifically relating to the production of gowns; N95 and surgical masks. Given demand pressures, manufacturers require advanced payments from buyers to confirm orders for raw materials and to reserve manufacturing capacity (UNICEF, 2020).

Supply bottlenecks

UNICEF (2020) notes that COVID-19 has affected global logistics caused by reduced airfreight capacity and workforces at airports, ports and warehouses. Logistics companies have also shut down or had severe movement restrictions imposed on them in terms of COVID-19 regulations local governments around the world have put in place to reduce virus transmission. This has also affected UNICEF's supply operations.

¹ Vertical integration refers to a strategy where company owns or controls all aspects of the value chain including, for example, the manufacturing and the wholesale or retail supply of PPE items.

COVID-19 has highlighted weaknesses in supply chains across the world. Latterly, healthcare systems in many countries have outsourced the manufacturing of PPE production to low labour-cost countries such as China. For example, the greatest concentration of mask production is in China and has been estimated at between 80-90% of production. When it comes to the production of gloves there is a greater diversity of sources and the largest producers are Indonesia Malaysia and Thailand with smaller producers located in countries such as Turkey and the Philippines (ADB Briefs, No 30 April 2020). This concentration of production at the outset of COVID-19 created bottlenecks and constrained supply when there was a surge in demand for PPE. China also cut its exports at this time because of enforced factory lockdowns and bans on travel. Compounding this weakness were flaws in inventory management and weaknesses with the just-in-time system of supply management. This resulted in the overall reduction in national stocks of PPE materials when demand for these materials spiked. (ADB Briefs, p.2, April 2020)

Besides the geographic concentration of PPE producers and weaknesses with inventory management, other obstacles to global PPE supply include (ADB Briefs, p.3, April 2020):

- Export bans implemented in various countries: for example, the exporting of face masks and key materials was banned in various countries to ensure supply in those countries. Examples include Germany; Malaysia; PRC; Republic of Korea; the Russian Federation; Thailand; Bangladesh
- Raw material shortages: there was a shortage of key components in the production of N95 masks for example
- Machine capacity: bottlenecks developed in production lines for key components and the time taken to assemble additional production lines
- Other bottlenecks: this includes transportation and shipping constraints caused by roadblocks and quarantine measures as well as a limited workforce due to illness

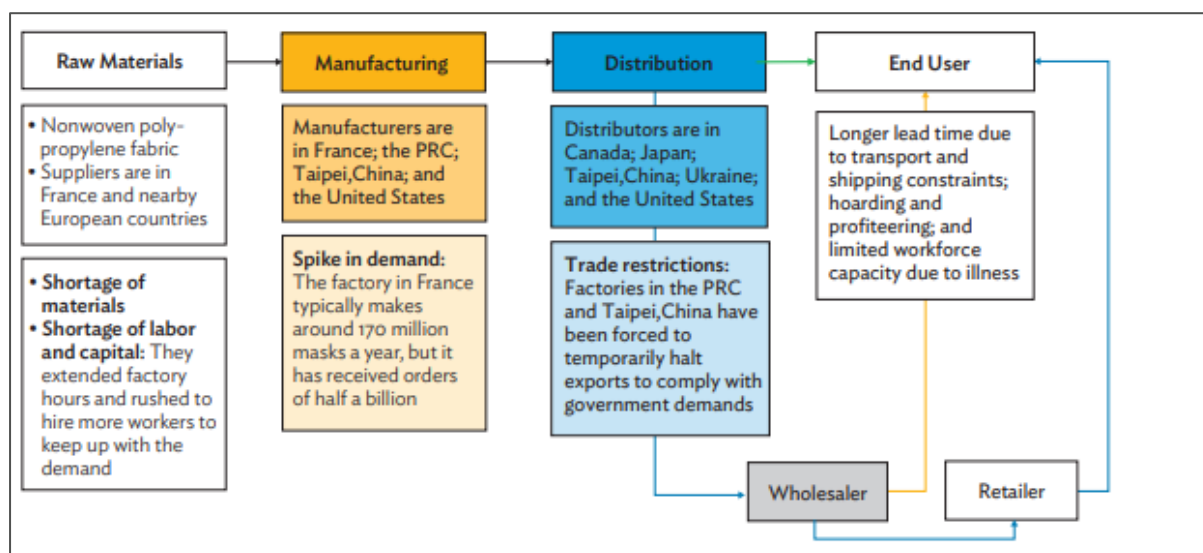
With respect to export bans, Gereffi (2020) notes that despite the growing diversity of established PPE exporters (shown in Figure 1), shortages have been aggravated by US. President Trump's trade war with China in 2018. This imposed an additional costs due to tariffs and led to the more serious and widespread problem of export controls which spread to nearly 80 other countries that also introduced export controls or restrictions of COVID-19 products by April 2020 (Gereffi, p. 291, 2020).

Demand for PPE

PPE demand is forecast to grow at a Compound Growth Rate (CAGR) of 7.8% between 2020-2025. This is attributed to the increasing number of COVID-19 cases in conjunction with the growing industrial awareness of the need for employee protection in the workplace (Businesswire, 2020)

Shortages in PPE supply are illustrated in the anticipated demand for N95 face masks. These masks are vital for medical staff because they provide a high level of filtering of fine airborne particles including the COVID-19 virus (blocking 95% of small particles). These masks are disposable and therefore there is an ongoing demand for them (Gereffi, p., 293, 2020). The US government estimated that in March 2020, 290 million N95 masks would be required every month². Actual supply was far below the anticipated monthly demand which was approximately 80 million masks per month (Gereffi, p. 294, 2020). The shortfall would have to be procured locally or through imports which are difficult to secure because of export controls imposed by most PPE producing countries (Gereffi, p. 294, 2020). Figure 5 illustrates the key supply-chain pressure-points in the production of PPE.

Figure 4: An Illustration of Face Mask Supply Chain Bottlenecks



Source: ADB Briefs No. 130, April 2020, licensed under Creative Commons Attribution 3.0 IGO license (CC BY 3.0 IGO)

3. Mitigating Supply Chain weaknesses

UNICEF (2020) notes that during March and April 2020, it increased its 'pipeline' of contracted PPE supply from thousands of units to millions of units scheduled for delivery between March and May 2020 (Figure 6). Despite markets facing severe disruptions and significantly increased pricing pressure, UNICEF has been able to maintain reasonable prices across the different PPE commodities. UNICEF's success in accessing more than 1,000 suppliers, mainly from China

² Estimated monthly US demand is from the US Department of Health and Human Services

(including manufacturers and wholesalers) has enabled it to secure key PPE products, such as 50 million surgical masks, 24 million respirators, 6.9 million coveralls, 3.6 million surgical gowns, 1.9 million goggles, 110,000 infrared thermometers and 31.6 million face shields. Some of this equipment has already been distributed to countries in need.

See: Figure 5: *Supply contracted through UNICEF (January-May 2020)*, Source: UNICEF (2020), <https://www.unicef.org/supply/stories/covid-19-impact-assessment-and-outlook-personal-protective-equipment>

Improving supply chains to assist developing countries

Multilateral bodies are assisting regions in need of PPE supplies, especially those with lower and middle-income countries. This section highlights some examples of this.

Latin America

In South America, UN agencies, together with international stakeholders have a global supply chain that has helped the Pan American Health Organisation (PAHO) distribute 1.4 million vital PPE items to 25 countries in the region. The supplies were sourced from PAHO's own regional emergency warehouse in Panama. Additionally, UNICEF promised 220 000 face masks and thousands of face shields and gowns to Latin America and the Caribbean. Despite these additional efforts, organisations including Doctors Without Borders, and Médecins Sans Frontières (MSF), have struggled to maintain sufficient supplies to countries in the region such as Brazil and have had to ration equipment such as N95-grade masks. These supply shortages are expected to become even more critical as South America moves into its winter and influenza season. The North, Central America and Caribbean hurricane season is expected to worsen PPE supply shortages. This hurricane season is expected to be one of the most severe in history (Rubin et.al.,2020).

Africa

To meet the demand for PPE supplies, the African Union (AU) member states have developed a continental strategy to procure medical equipment and PPE supplies. The Africa Medical Supplies Platform (AMSP) enables all member states to purchase this equipment. Demand for medical supplies on the platform is reportedly high and includes AU member states; leading international non-governmental organisations and international and African foundations. It is envisaged that the platform will help secure supplies to countries in a timely manner. Member states of the Caribbean Community have also joined the platform (Mzekandaba, 2020). The Bill and Melinda Gates Foundation, have reportedly committed to join the platform to assist with the procurement of therapeutic drugs to combat Covid-19 (Mzekandaba, 2020). One of the platform's successes is the procurement of PCR test kits after Africa Centre for Disease Control (CDC) had secured \$15 million from the MasterCard Foundation (Mzekandaba, 2020).

In addition to the initiatives described above, to further resolve the problem of fragmented demand and to coordinate an approach to procurement, WHO and several partners (including MSF), have established an online supply portal through which countries can order PPE. Members of the consortium behind the WHO supply portal can advise on prioritisation between countries, although there is no formal global mechanism for assigning PPE to the places most in need (Burki, 2020).

International Finance Corporation (IFC) Platform

The demand for face masks is estimated to be four times the world's current manufacturing capacity. Demand for ventilators, is 10 times bigger than existing capacity and it is claimed that over the next four months, there will be a shortage of more than 300 million test kits (International Finance Corporation, 2020).

According to the IFC (2020) more than \$60 billion in investment is required to expand manufacturing and delivery capacity to meet global demand in response to the pandemic. The IFC has therefore launched a \$4-billion financing platform to increase the access of developing countries to critical healthcare supplies required to fight the pandemic, including masks, ventilators, test kits and, eventually, vaccines. The platform will be used to expand access to essential health supplies by boosting capacity to deliver these products to developing countries. The intention behind the platform is to assist developing countries build sustainable and more resilient healthcare systems. It is further expected that the platform will assist low income countries in the development of their own manufacturing capacity for health products (International Finance Corporation, 2020).

According to the IFC, this initiative is part of the World Bank Group's effort to strengthen developing countries' response to pandemics and to increase disease surveillance and improve public-health interventions. This initiative complements the efforts of the World Bank aimed at helping developing countries access medical supplies (International Finance Corporation, 2020).

PPE supply solutions for subsequent waves of COVID-19

As Northern Hemisphere countries have opened their economies and moved from strict lockdowns, COVID-19 infection rates have surged (Guardian, 17 August 2020). Similarly, in the Southern hemisphere the same pattern is expected, with a second wave of infections anticipated in South Africa for example (eNCA, August, 2020). The need for continuous production and supply of PPE, is therefore likely for the foreseeable future. Bamber et.al (2020), note that the health care industries' globalised production base provides a sound platform for the ongoing supply of PPE around the world. With the diversity in global production of PPE and the complementariness of global supply chains of medical equipment to deal with the pandemic, measures are needed to protect these supply chains, including: allowing for the free flow of goods across international borders; permitting the movement of essential labour across borders; facilitating trade logistics and being cautious before deciding to nationalise parts of the supply chain (Bamber et.al., p.5,2020).

To prepare for subsequent waves of COVID-19, Kaliya-Perumal et.al. (2020) advocate focussing on the development of national stockpiles of PPE. Models to understand how the development of national stockpiles can be built need to be examined. Canada and the United States have a working model of a national emergency strategic stockpile (NESS). Financial constraints may prevent countries from having physical stockpiles. In these cases virtual stockpiles, comprising an inventory of items for a future outbreak can be developed together with a detailed logistics plan that includes companies (as collection points) that are designated to provide all essential PPE. Planning for the virtual stockpile accounts for all aspects of supply including transportation and storage facilities (Perumal et.al.,2020). The advantages and disadvantages of both options of PPE stockpiles are highlighted by the authors below.

Figure 6: Advantages and Disadvantages of Having Physical Versus Virtual Health-Related Stockpiles

Physical stockpile	Virtual stockpile
Advantages	
Always available for dispatch	Finances are allotted only if a crisis occurs
Faster decision to deployment times	Maintenance free
Disadvantages	
Cost of creation	Dependence on companies to manufacture essentials at the time of crisis
Quality control	Organizing the supply chain at the time of crisis
Maintenance and security	Slower decision to deployment times

Source: Kaliya-Perumal et.al, 23 July 2020, reproduced with kind permission from [Canadian Public Health Association](#)

In the developing world, some countries have found innovative solutions to address some of the shortfalls of PPE and at the same time sustain their businesses during lockdown:

- Vietnam has converted some of its factories making clothing and apparel to making face masks and other PPE. This production switch has allowed some firms to stay operational during lockdown (Fibre2Fashion News Desk, 2020).
- Tanzania secures most of its PPE and other medical equipment from imports. However, it is now able to supply some 5% of its PPE through retooling some of its factories. Its local production includes hand sanitisers, surgical masks and chlorine tablets. Input material for the production of these items can be locally sourced. However, this only comprises 50% of all COVID-19 PPE needs. The main obstacle to overcoming the rest of PPE needs is the expensive machinery needed to make key raw material input (Dalberg Advisors, 2020).
- In wider Africa, clothing manufacturer, Hela Clothing has refitted some of its factories (including its Kenya operation) to help the surge in demand for PPE from hospitals and other industries in Africa. Hela produced 10 million face masks in Kenya during April and May. These masks were three-ply surgical masks or fabric variants. Hela’s Kenyan plant is acquiring specialist machinery to produce more sophisticated N95 respirator masks. There is a critical need for this class of masks globally and the WHO estimates that with COVID-19 there will need to be a 40% increase in the manufacturing of these masks and current global production is less than a quarter of projected demand. Hela is supported by the IFC to retool itself as a producer of PPE (Maylie, 2020).

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