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Supply Chain Challenges of Personal Protective Equipment, and Methods of Mitigation Amidst COVID-19 Pandemic: A Qualitative Study from Sri Lanka, a Developing Country in South East Asia

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Abstract

Background: Personal Protective equipment (PPE) are essential for healthcare workers to prevent disease spread. With COVID-19 pandemic, the PPE supply chain was adversely affected. This case-study describes the PPE supply chain challenges and mitigation measures during COVID-19 pandemic in Sri Lanka.

Methods: In-depth interviews were conducted among 14 randomly selected officials, who were directly involved with PPE procurement to Ministry of Health Sri Lanka, at the Medical Supplies Division, State Ministry of Production Supply and Regulation of Pharmaceuticals and State Pharmaceutical Corporation. Study sample was collected until data saturation. A semi-structured interviewer guide was used. Thematic analysis was done.

Results: Study revealed that the preparation for an un-interrupted PPE supply prior to pandemic hitting the country was unsatisfactory. High cost; unavailability of certified suppliers; unavailability of PPE globally and locally; lack of raw materials; quality failure; delays in procurement procedure; increased demand and its dynamicity; and lack of funds challenged the PPE supply chain. Intergovernmental negotiations; encouraging local production and purchasing from local suppliers; issuing guidelines for PPE usage; and obtaining support from development partners/INGOs were the mitigation strategies that were undertaken.

Conclusions: Sri Lanka, as a country with limited resources, has faced several PPE supply chain challenges during the pandemic. Policy makers should undertake measures to improve the readiness prior to similar disasters in the future. Encouraging local PPE production, establishing quality assurance mechanisms, developing relevant guidelines and improving staff capacity on procurement process are recommended to face disasters of such caliber in the future.

Keywords: Personal Protective Equipment (PPE); Supply chain, COVID-19; Challenges; Qualitative; Developing country; South-East Asia; Sri Lanka

Introduction

The novel Coronavirus disease was first reported in Wuhan, China in December 2019. Considering the burden and the rapid spread of the disease, the World Health Organization (WHO) declared it as a public health emergency of international concern on 30th January 2020 and as a pandemic

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on 11th March 2020 [1]. As of 4th January 2023, there were 655,689,115 confirmed cases and 6,671,624 deaths reported globally [2] and, the pandemic continues to affect the economies [3] and challenges the health systems of the countries across the globe [4,5].

Sri Lanka, a low-income country in the South-East Asia, reported 671,903 confirmed cases and 16,817 deaths by 1st January 2024 [6]. Sri Lanka undertook 'whole-of government', 'whole-of-society' approach with urgent and aggressive actions to contain and mitigate the disease within the country, and commenced the vaccination programme against COVID-19 on 29th January 2021 [6].

It is well known that COVID-19 is transmitted through aerosols/droplets/respiratory secretions of an infected individual and also via contaminated surfaces and equipment [7]. Healthcare workers hence, were at a higher risk of infection, as they were continuously exposed to aerosols produced by patients during medical examination and management. Personal Protective Equipment (PPE) are used by healthcare workers as a universal precaution, to protect themselves from being exposed to various diseases including COVID-19. If not properly protected, they, who were the front-line service providers against Coronavirus disease, could have got infected and could have spread the infection to their families, friends and patients. Considering this risk, the WHO recommended the healthcare workers to essentially wear PPE during patient care during the pandemic period [8].

Considering the rapid surge of demand for PPE during the pandemic, the WHO emphasized the importance of rapid increase in their manufacturing by the PPE industry. The WHO also urged the governments to quickly act on increasing and securing their PPE supply as well [9]. Nevertheless, a mismatch between the demand and the supply of PPE across the globe occurred following the rapidly increasing COVID-19 infected persons, due to several reasons collectively overwhelming the global production of PPE [8,10]. Also, the local supply chains of PPE were affected in many countries, including Sri Lanka, due to lockdowns, increased costs, travel bans and factory shut-downs [11]. However, despite these hardships, considering the importance of PPEs for protecting the healthcare workers, especially during the pandemic, many countries across the globe, including Sri Lanka, adopted different ways to maintain the supply chain of PPEs, within their capacities.

In the Sri Lankan health system, the purchasing of all PPE is done centrally by the Medical Supplies Division (MSD) of Ministry of Health (MoH) (Figure 1).

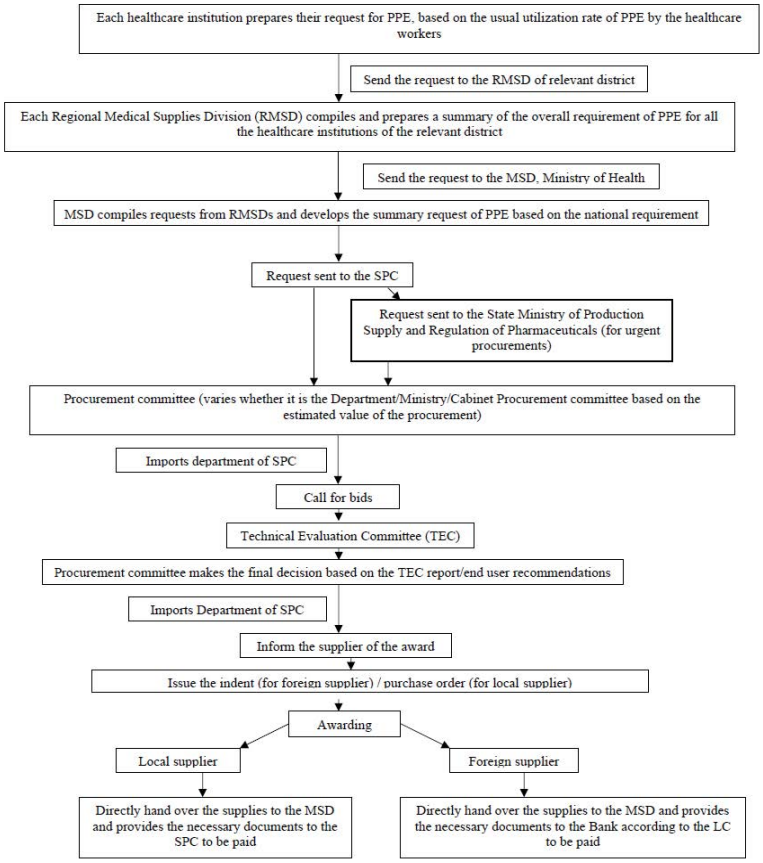

Figure 1: General and urgent procurement process of PPE to the Ministry of Health Sri Lanka.

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Nevertheless, it is important to note that reportedly there was a massive gap between the demand and the supply of PPE across the globe and in Sri Lanka. Thus, this study was conducted with the aim of assessing the supply chain challenges in provisioning PPE to Sri Lanka, and the measures that were undertaken to mitigate these challenges, as a resource limited setting, during the COVID-19 pandemic. Findings of this study would give an insight to the Sri Lankan policy makers and would support in developing plans to secure uninterrupted supply of PPE during disasters in the future. In addition, sharing the experience of Sri Lanka would provide baseline information for many such economically developing countries across the world, to plan and face disasters of similar caliber in the future.

Materials and Methods

In-depth interviews among officials who had been working for three or more years at the MSD (n=5), State Ministry of Production Supply and Regulation of Pharmaceuticals (n=4) and State Pharmaceutical Corporation (SPC) (n=5), who were directly involved with the procurement of PPE for the MoH (N=14), were conducted by the author, at a place of their preference, on appointment basis, while, maintaining their privacy and confidentiality. Since conducting focus group discussions was not feasible at the time of the study, due to the restrictions placed within the country on gathering people and as the officials were reporting to work on roster basis, during the pandemic, in-depth interviews were conducted. The relevant officials were randomly selected by the authors from institution specific sample frames of all officials who were directly involved in procuring PPEs for the MoH, using computer generated random numbers.

The interviews were conducted during June – August 2022, while the country was facing the third wave of COVID-19 outbreak. A semi-structured interviewer guide with open ended questions, which was developed following literature review and discussions with an expert panel consisting of Public Health Specialists, Medical Administrators, Procurement Specialists and higher officials of MoH, was utilized to obtain data regarding the measures taken by the MoH to ensure an un-interrupted supply of PPE during the preparation phase of COVID-19 outbreak; change in the demand for PPE during the pandemic; challenges faced in the supply chain of PPE during the pandemic and measures undertaken to mitigate those challenges. Further questions were also asked as necessary, whenever new themes imaged during the interviews. The interviews were held in local languages (Sinhala and Tamil languages) and in English language (as per the request of the study participant) the duration of the interviews ranged from 30 minutes to one and half hours.

The study sample for the interviews was obtained until the point of data saturation. Sampling, data collection, transcribing and data analysis were done in parallel and the point when the collected data did not give rise to any new emerging themes was considered as the point of data saturation. Following informed written consent from the study participants, all interviews were recorded and then were transcribed verbatim initially in local languages. These were then translated to English language by two independent language experts and were back translated to local languages by two separate independent language experts, to ensure the accuracy. Thematic analysis of this transcribed text was conducted. Ethics clearance to conduct the study was obtained from the ethics review committee of the Faculty of Medicine, University of Colombo, Sri Lanka (ID:EC-21-049).

Results

The themes identified following the analysis were as follows:

Preparatory measures undertaken for an un-interrupted supply of PPE before the pandemic hit the country was not satisfactory

Participants indicated that the MoH undertook certain measures to assure the supply chain of PPE, however, it was not satisfactory.

"The Health Ministry developed a monitoring system for PPEs. Using all data available, a model was developed to predict the potential requirement of PPE and initiated procurement of PPE closer to that amount, even before COVID was widely spread in the country. We thought we were ready. But never expected the gravity of the disease to be this high" (M02).

"Just like Ebola, people though that this also will not hit the country. Therefore, although we were prepared to a certain extent, it was not satisfactory" (M03).

There was an increased, dynamic demand for PPE during the pandemic

The respondents indicated that there was a drastic increase in the demand for PPE during the pandemic period compared to the pre-pandemic period.

"The demand for PPE kits increased especially after the first wave" (M02).

The demand for the N95 masks and other PPE components was considerably high during the pandemic;

"After the pandemic occurred, the demand for N95 went sky high" (M01).

"Demand for all the PPE components however alarmingly increased with the occurrence of the pandemic" (M01).

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"We used to have only one order annually for surgical face masks before the pandemic. Now we need to procure at a higher frequency and in significantly higher numbers. It is the same for all PPE" (M02).

Considering the PPE kits (single package containing all components of PPE such as masks, apron, gloves, face shield, goggles), the MSD newly designed and developed the specifications for each component, since it was not previously used in the country.

"We had only separate PPE components. We did not have all together in one pack. Such kits were not available in the market for us to purchase. Therefore, we designed and made specifications for PPE kit with the support of Physicians at the National Institute of Infectious Diseases" (M01).

However, this demand for PPE was found to be unrealistic.

"The numbers they requested were sometimes unrealistic. In some hospitals, while the Doctors wore only an apron to manage patients, certain other staff categories wore the whole kit. The fear psychosis played a role" (M03).

"Initially, healthcare staff changed PPE kits 2-3 times per day, due to reasons such as fear of spreading the infection, difficulty in wearing one PPE kit continuously in our temperate climate, and also, because we did not provide them a guideline on using PPE kits" (M02).

Challenges faced in the PPE supply chain during the pandemic

Several themes were identified as challenges of the PPE supply chain during the pandemic.

High cost of PPE:

One of the major challenges faced in the supply chain of PPE was the high cost of PPE kits and PPE components.

"With the demand and scarcity of PPE in the world, the prices suddenly went up during the pandemic. A PPE kit each costed about LKR 7000/=. Before the pandemic, N95 masks were purchased at a low rate and then its price went up to LKR 400/= each, during the pandemic. Whereas, the price of the surgical gloves, which was about LKR 12/= per pair went up to LKR 16/=" (S01).

"Prior to the pandemic, we purchased a surgical face masks at a rate of LKR 3.50-4.50 each. Then the price went up to LKR 45/= during the pandemic" (S02).

Unavailability of National Medicines Regulatory Authority (NMRA) certified suppliers to supply PPE:

In order to procure medical supplies and medicines to Sri Lanka, like in any other country, it is essential by law that the product and the supplier is assessed for quality and certified by the NMRA. Unavailability of adequate number of NMRA certified suppliers in the country was a challenge faced during the pandemic, to meet the increasing demand of PPE.

"We had only two suppliers who had the NMRA certification for face masks at the time. There were people who could provide PPE but, they were not certified. Therefore, we had to depend only on few suppliers" (P01).

***Unavailability of PPE locally and globally**:*

Unavailability of PPE globally and locally due to issues in the production process was another challenge.

"With the pandemic spreading, there were no PPE available to purchase from anywhere in the world. Countries did not sell as they kept reserves for their needs, as it was highly uncertain" (P01).

"Even we manufactured locally, the workers were reluctant to come for work. Even transport facilities were provided and over-time was paid, they were reluctant to come. Therefore, the local production was low. Otherwise, there were no transportation issues regarding the supply of the products" (S04).

***Lack of raw materials for the local manufacturers of PPE**:*

There was a delay in PPE supply from the local manufacturers as the required raw materials were unavailable for them due to country lockdowns and closure of relevant factories.

*"Local manufacturers didn't get the required raw materials due to various reasons such as factory shutdown, country or area lockdowns in other countries, especially, China" (*S03).

Quality failures of the PPE products received:

There were several issues related to the quality of the PPE received.

"There were quality failures of the PPE. Sometimes items broke while testing the samples" (P01).

"There were quality issues with the masks we received" (S01).

Delays in the procurement procedure:

- Products not conforming to the specifications:

There were delays in the procurement procedures due to failures from the suppliers' side, such as not providing samples as requested, failure to supply certain items, and products not in line with the specifications requested.

"Some did not provide the requested samples for the technical evaluation committee (TEC) to assess, sometimes all the bids were not on the specifications required, but, submitted with the best items they had. This resulted in delays in the procurement process. There were instances we had to re-call tenders" (P02).

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Also, respondents reported that certain specifications given were unrealistic.

"The specifications given were unrealistic. None of the products in the local market could meet all the specifications. Therefore, either we should have practical specifications, or the TEC should select the best from the available lot in the evaluation, considering the circumstances. But, after the evaluation, they completely rejected the bids and had to re-call tenders" (P02).

- Lack of knowledge of the staff on the procurement process:

"There were delays due to the lack of knowledge on the procurement process among the staff including higher officials" (P02).

Dynamicity in the demand for PPE

As per the respondents, the demand for PPE was greatly varying, sometimes even daily. This dynamicity in the demand for PPE was a challenge for procuring as well as to maintain an uninterrupted supply of PPE.

"The demand for PPE was changing almost daily. There was no way that we could think of a fixed number of PPE to procure" (S02).

Lack of funds

With the increased cost of PPE, MoH had to spend a significant amount of funds for procuring PPE. The Dollar and the Rupee crisis has made the situation worst.

"Because of the Dollar crisis, people were facing issues with getting raw materials from foreign countries. Because of the Rupee crisis and the lack of funds, the suppliers have not been paid on time" (M02).

Measures undertaken to mitigate the challenges of PPE supply chain during the pandemic

Following themes were identified regarding the mitigation strategies:

Intergovernmental negotiations for PPE

When there were no PPE to be purchased in the market due to high global demand, inter-governmental negotiations had been done.

"The hierarchy of the country, spoke to the Presidents of other countries directly and requested for PPE for Sri Lanka, playing a significant role" (M02).

"With all the restrictions, the local manufacturers had issues with obtaining the raw materials from China. The government got involved and the products were brought into the country as a government to government negotiation by air freight" (M01).

Promoting local production of PPE and purchasing from local suppliers

Encouraging the local manufacturers to produce PPE was another mitigating strategy used. In addition, local textile manufacturers supported the MoH by producing PPE as well.

"There were local manufacturers who produce and export PPE to other countries. We requested them to produce PPE as per our requirements as well" (M03).

"One of the local textile factories, used one of their factories, only to produce PPE for us. And most of the consignments were given free, especially during the second wave of COVID" (S01).

"We have a factory producing N95 masks in the free trade zone now and we have another textile factory producing PPE kits for the country" (S03).

Further, there was a shift from the foreign suppliers to local suppliers for PPE during the pandemic.

"Earlier we imported all PPE from foreign suppliers, mostly from China, India and Germany." (S02).

"Gradually, the local manufacturers established the manufacturing plants in Sri Lanka. So, from foreign suppliers, we slowly shifted to the local suppliers. Now we get the products mostly locally" (S03).

The respondents stated that the shift to purchase from the local suppliers provided added advantages.

"Procuring from the local suppliers saved a lot of money to the government. It must have saved at least about LKR 3.00 per item. Since the procurements were millions in quantity, it indeed saved a lot of money per consignment. Also, the supply delays were minimum" (S01).

Development of guidelines on the rational usage of PPE

Considering the demand and supply mismatch, guidelines were issued by the MoH on rational use of PPE during the pandemic.

"We prepared and disseminated guidelines on the rational use of PPE" (M01).

Introduction of waivers for NMRA registration

Since, the low number of certified suppliers was an issue, the NMRA had issued waivers of registration to encourage local suppliers to be registered.

"Since we had very limited number of registered suppliers, the government and NMRA decided to issue waivers for the registration" (M03).

Support received by the development partners and international non-governmental organizations (INGO)

The development partners and INGO have supported the MoH in obtaining PPE during the crisis.

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"Due to the high lead time in manufacturing, imports and quality failures, sometimes we had failed to supply PPE on time. In such instances, Sri Lanka Red Cross and the WHO country office has supported us in obtaining PPE" (M01).

Discussion

This study was conducted with the aim of identifying the supply chain challenges of PPE and mitigation strategies that Sri Lanka undertook amidst the COVID-19 pandemic. The study revealed that Sri Lanka was not well-prepared to ensure an un-interrupted supply of PPE, given the highly dynamic demand of PPE during the pandemic. Thus, Sri Lanka had faced several challenges in supply chain of PPE during the COVID-19 pandemic including, unavailability of PPE in the global market; high cost of PPE; dynamic demand for PPE; lack of raw materials for local production; unavailability of certified suppliers; quality failures; delays in the procurement process; and lack of funds. Thus, promoting local production and supply; development of guidelines on rational use of PPE; issuance of NMRA registration waivers; intergovernmental negotiations and obtaining support from development partners were the mitigation strategies that Sri Lanka had undertaken in the pandemic context.

COVID-19 Pandemic indeed was an opportunity to obtain an insight and experiment with the potential solutions to such emergencies and disasters in the future, especially for low resource settings like Sri Lanka[18].

It is essential that healthcare staff wear PPE as the frontline workers of COVID-19 response, as they were continuously at a higher risk of contracting the disease [12]. In addition, healthcare staff being positive for COVID-19 would have added additional pressures on the health system due to the lack of already limited human resources, especially in resource limited settings like Sri Lanka [13].

This led to a drastic increase in the demand for PPE globally [7,14,15]. This drastic increase in demand for the PPEs during the pandemic was also evident in Sri Lanka. The secondary data analysis done by the author (data obtained from the MSD) found out that there was a 1.2 times higher demand for surgical gloves; 5.7 times higher demand for Aprons; 3.5 times higher demand for face masks; 23 times higher demand for face shields; and 2.2 times higher demand for surgical hair caps during the pandemic (2020-2021) compared to that of the pre-pandemic period (2018-2019), in Sri Lanka. Additionally, the demand for PPE kits was originated only after the occurrence of the pandemic. Also, a considerable increase in demand for PPE was seen after October 2020, following the Navy cluster – emergence of the second wave of COVID-19[6] and April 2021, following the carefree new year celebrations and introduction of Delta variant into the country – emergence of the third wave of COVID-19 in Sri Lanka [6].

The UNICEF [16] and WHO [9] indeed predicted this high demand for the PPEs during the pandemic and as a result, China, being the major PPE producer for the global market, reportedly drastically increased their production of PPEs as well, compared to that of the pre-pandemic period [15]. However, despite the high demand, shortage of PPE was evident in many countries across the globe [14,15,17], resulting in WHO Director General Tedros Adhanom Ghebreyesus to state that "the chronic global shortage of personal protective equipment is now one of the most urgent threats to our collective ability to save lives"[13] during the pandemic.

According to Cohen and Rodgers [14], 2020, even though the governments were warned of the gravity of the outbreak, most governments were underprepared to face the pandemic. This lack of preparation was well evident by the increased numbers of health care workers being affected by the disease, who either became sick or died [14,15]. It is also reported that, despite the known shortage of PPE across the globe, governments did not respond to the crisis [17] and had not adequately built or sustained the required PPE stocks to face the pandemic [18]. The condition was indicated to be the same in Sri Lanka as well, where the preparatory measures undertaken were not adequate. 'Taking the condition lightly politically' [13] as well as lack of funds to purchase the required stocks as desired, would have been a limiting factor for many countries across the globe especially, the low and middle-income countries.

With the rapid spread of COVID-19, the dynamicity of the demand for PPE was increased. Our study indicated that the demand for the PPE considerably changed almost daily, greatly challenging the PPE supply. It was reported that forecasting the demand for the COVID vaccines was easier compared to that of PPE [15]. High cost of PPE, lack of funds and unavailability of PPE globally were some of the major PPE supply chain challenges faced by Sri Lanka. Since the pandemic started, the prices of PPE markedly increased globally where, the price of the N95 masks increased by three times; surgical mask price by six-fold, and surgical gowns price had doubled [15]. This price hike along with the lack of funds limited many economically developing countries in the world including Sri Lanka, in accessing PPE during the pandemic. With the emerge and the wide spread of COVID-19 in China, which is the major PPE producer to the world, PPE production came into a halt, affecting their global availability [15]. In addition, the national policies restricting the export of PPE[15,17], international travel restrictions [15,19], misinformation, panic buying and stockpiling [8,20], factory closure, country/area lockdowns, workers being made redundant, also contributed to the global unavailability of the PPE [18]. In addition, companies and countries world-wide

have been implementing lean supply chain management strategies including just-in-time, with the aim of minimizing the cost and as a methodology of inventory efficiency [17]. Thus, leading the production of PPE to become more geographically concentrated [18]. As a result, there was a significant depletion in the national PPE stocks with no buffer stocks to be utilized [10,18,19], especially affecting the low and middle –income countries.

On the other hand, it is important to note that although a considerable amount of discussions about the equitable access to vaccines, drugs and diagnostics related to COVID-19 had happened in the world, such attention was not given for PPE [15]. Thus, it is essential that a global health care approach and global stewardship is available for combating such pandemic situations in the future [17].

The current study found out that lack of raw materials to the local manufacturers was a major limitation to produce PPE locally, which was also similar to the findings of Burki, 2020 [15,19]. As China has been the major supplier of the raw materials for the production of PPE globally, the companies around the world that had depended highly on China failed to function in their full capacity to produce PPE[19]. Nevertheless, COVID-19 pandemic ultimately surfaced and challenged the fact of medicines and health care products being produced by 'globally sourced materials' [20].

With the emergence of novel suppliers into the PPE supply chain, it was evident that there were various quality issues with PPE [18,21]. Similarly, the current study found out that there were quality failures with PPE. Also, it is reported that certain health care systems have purchased PPE from sources without having the capacity and facilities to check for their quality, as this is usually done by the distribution partners [21]. Hence, it is recommended for the health systems to focus on quality assurance, especially during a crisis of this nature in the future [18].

Also, in line with the findings of the current study, it is evident that poor procurement capacities, poor information infrastructure, poor data management, lack of accessibility to real time data on consumables, lack of integration and poor inventory management capacities have also resulted the gap between the supply and the demand of PPE across the globe [17,18]. These could be major limiting factors especially in low and middle-income countries.

Nevertheless, in the backdrop of these challenges in the PPE supply chain, countries including Sri Lanka have undertaken several strategies to mitigate the impact during the pandemic at least to a certain extent like, exploring the alternatives for PPE and possibility of re-use after sterilization; implementing strategies to reduce PPE use and requesting justifications for shortage of PPE by higher authorities [17,18]. The MoH Sri Lanka also prepared and disseminated a guideline on the rational use of PPE in hospitals in the context of COVID-19 [22].

It is reported that by April 2020, WHO has provided 0.5 million PPE to 47 countries across the globe [10], including Sri Lanka. Production of re-usable medical products, local refurbishment of the supplies and local manufacturing of the medical supplies, prevent depending on limited suppliers for medical products were some of the proactive solutions that several countries across the world including Sri Lanka has undertaken during the pandemic [10,18]. This shift of enhancing local production and encouraging local suppliers was evidently highly beneficial in Sri Lanka. Hence, would be an important lesson learnt for the developing countries across the world.

Conclusion

It is evident that Sri Lanka was not well prepared for an uninterrupted supply of PPE to cater the increasing demand during the COVID-19 pandemic. Challenges faced in the PPE supply chain by Sri Lanka included global and local unavailability and high cost of PPE; unavailability of certified suppliers; lack of raw materials for local production; quality failures; delays in the procurement procedure; dynamicity of the demand and lack of funds. Based on the lessons learnt from Sri Lanka, mitigation strategies that could be undertaken to overcome these challenges by low and middle-income countries across the world would be, to focus more on disaster preparedness, encourage local production and suppliers; development of quality assurance mechanisms, developing relevant guidelines and improving the staff capacity on the procurement process. Further, intergovernmental negotiations and obtaining support from the development partners are avenues that can be considered as well.

Declarations

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Competing interests

The authors declare that they have no financial and non-financial conflicting interests.

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