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7**ABSTRACT**

The health of every individual in the world is greatly influenced by global health issues and threats which are usually caused by international trade and voyage. These threats which have exposed the inadequacies of healthcare systems across the globe include the rapid spread of non-communicable and infectious diseases, pandemics, hunger and starvation, natural disasters, shortage of healthcare personnel and climate change. These threats have led to economic and social disruption in almost all spheres of human lives such as agriculture and education.

**Aim:** Against this background, this study reviews global health challenges and the importance of robots in global health. This study also appraises the factors hindering the effective use of robotic technology to improve global health.

**Methodology:** A total of 41 literatures relevant to the subject matter were obtained from diverse scientific electronic databases including CiteseerX, Science Direct, Google scholar, IEEE explore, indexCat, PubMed and National Library of Medicine.

**Results:** The study showed that robots can be used to improve global health by diagnosing and treating infectious diseases, reducing the dangers of human contact during pandemic and delivering food and medicines to infected individuals. The study also showed that robots can be used to reduce harmful gases released into the atmosphere and also limit the anxiety and fear of vaccination. The study also revealed that high cost, privacy-related issues, interoperability challenges and the fear of displacement of jobs by robots are some of the factors hindering the effective use of robotic technology to improve global health.

**Conclusion:** This paper suggests that adopting a common standard for robots of different brands and education strategies are some of the strategies that will facilitate the effective use of robotic systems to improve the health of individuals across the globe.

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**Keywords:** *Global health, Global health threats, Health, Robots.*

**1. INTRODUCTION**

The rapid and exponential rise in the frequency of international commerce, trans-border population flows, and the globalization of food supplies, feeds, and medicine have introduced diverse health risks that directly and indirectly affect the health of the world's population. As the world economy also becomes increasingly globalized due to various advances in technology, transportation, electronic communication modalities and common interests, global health is threatened by the emergence and re-emergence of infectious diseases and pandemics, climatic change, air pollution, food and energy crisis, natural disaster, social inequality and migration of healthcare personnel [1]. The effect of these global health threats includes an unstable economy, inadequate security, overuse of healthcare facilities, the rapid spread of infectious diseases, hunger and starvation, travel ban and decline in the number of tourists, rising cost of healthcare, closure of schools and educational facilities as well as environmental pollution [2, 3]. Several governmental and non-governmental organizations such as the Center for Disease Control (CDC) and World Health Organization (WHO) are committed to providing tools and practices for reducing global health threats such as quality disease surveillance, a well-trained workforce, rapid and accurate public health and emergency response [4]. In spite of this, the world is still menaced by new and rising global health challenges annually. For instance, an average of

29 2000 people in the United States of America is diagnosed with malaria after international  
30 travel annually [5]. In addition, Hurricane Matthew claimed the lives of at least 546 Haitians  
31 in 2016 while the emergence of infectious diseases and pandemics such as influenza,  
32 Middle East Respiratory Syndrome Coronavirus (MERS-CoV), Ebola, ZIKA and Coronavirus  
33 Disease 19 (COVID-19) is becoming rampant in countries across the globe.

34 Robots have been used in recent times to address global health issues [6, 7]. For instance,  
35 they have been used to reduce the spread of infectious diseases and pandemics by  
36 assisting healthcare workers in dispensing medicines, drawing blood as well as checking  
37 and monitoring infected patients' vital signs. In addition, robots have been used to address  
38 hunger and starvation by reducing farm waste, improving food quality and safety, fighting  
39 against pests, pathogens, and diseases, and engineering new and improved food products  
40 [8]. As a result of the benefits of robotic systems in containing global health threats,  
41 technologically advanced countries such as Japan and China have deployed a variety of  
42 robots for ameliorating global health challenges, while most economically emerging  
43 countries cannot afford these systems due to high cost of procurement, maintenance,  
44 training and integration [9]. In addition, usability issues, privacy-related issues,  
45 interoperability challenges, and the fear of displacement of workers from their jobs are some  
46 of the factors hindering the effective use of robotic technology to improve global health.  
47 Consequently, the adoption of robotic technology by different countries across the globe to  
48 curb global health threats is low. This ultimately leads to a high disease burden and an  
49 increase in mortality rate. Based on this background, this paper addresses the importance of  
50 robots in global health and the problems confronting the effective use of robots in resolving  
51 global health challenges. This is to promote and sustain the health of the world's population,  
52 which is in line with the requirements of the Sustainable Development Goal 3 (SDGs), which  
53 emphasizes that all countries should promote the well-being of all individuals at all ages and  
54 also ensure that their citizens are healthy.

55 This paper is organized into seven sections. Section two introduces the concept of global  
56 health, section three provides the study methodology while section four reviews the  
57 applications of robots in combating global health challenges. Section five presents the  
58 challenges confronting the effective use of robotic technology in combating global health  
59 challenges, section six recommends the strategies for the effective deployment of robotic  
60 technologies in resolving global health threats, while section seven concludes the study.

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## 62 **2. METHODOLOGY**

63 A total of 98 literatures relevant to the subject matter were obtained in diverse scientific  
64 electronic databases including CiteseerX, Science Direct, Google scholar, IEEE explore,  
65 indexCat, PubMed and National Library of Medicine. In addition, 20 additional documents  
66 and WebPages were obtained from the Google search engine. The keywords used in the  
67 search process include "global health", "global health threats", "robots used to combat global  
68 health threat" and "robots in healthcare systems" The qualities of these documents were  
69 assessed based on the following critical appraisal guidelines.

70 1. Are the aims and objectives of the studies related to the subject matter?

71 2. Are the aims and objectives clearly defined?

72 3. Do the documents contribute to the body of industrial and research knowledge?

73 The qualities of the documents were appraised based on the answers to each of the  
74 appraisal guidelines. The study adopted a 3-point Likert scale which include strongly agree,  
75 strongly disagree and undecided to score the papers. The scores allotted to each scale are  
76 shown in Table 1.

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**Table 1. The likert scale for scoring the literatures for the study**

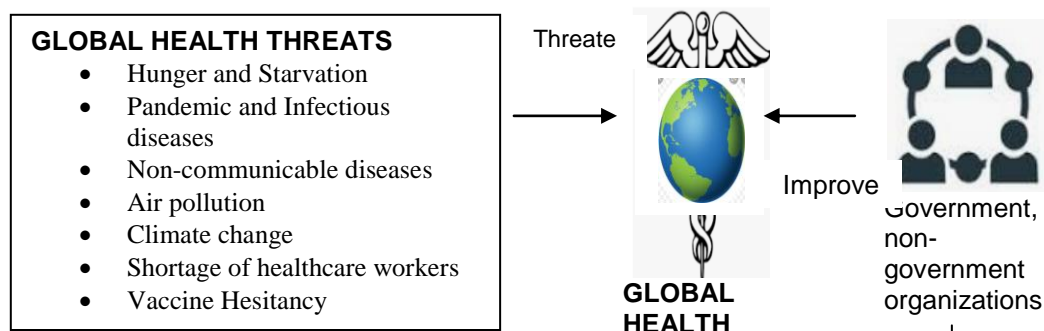
Score	Scale
1	Strongly disagree
2	disagree
3	undecided

The quality of each paper was determined by summing up the scores of the responses to the criteria guidelines in the Likert scale. The authors agreed that the qualities of the studies should be determined by considering papers with 50% score in the Likert scale. At end of this process, 77 papers were excluded from the review process while 41 papers which were considered relevant for the review were selected for the study.

### 3. OVERVIEW OF GLOBAL HEALTH

There is no commonly agreed definition for the term global health despite the recent global crises currently ravaging every nation across the globe, such as the COVID-19 pandemic, climate change, and food and energy crises [10]. Generally speaking, global health can be viewed as the process of improving the health of the world's population. It can also be defined as health issues that transcend national boundaries. Nevertheless, diverse authors have made different attempts to define global health in different ways concisely. Koplan et al. define global health as an area of study, research, and practice that emphasizes the importance of improving health and attaining equity in health for all individuals across the globe [11]. Beaglehole and Bonita view global health as a collaborative, trans-national research and action responsible for promoting all health [12]. Kickbush defines global health as health issues that transcend national boundaries and governments and call for actions on the global forces that determine people's health [13]. Macfarlane et al. view global health as the global improvement of health, reduction of health disparities, and protection against global threats that disregard national borders [14]. These definitions primarily focus on promoting the health of all individuals globally and a collaborative effort by all governments across the nations to provide equitable healthcare services for all individuals across the globe. These definitions ignore the causes of global health challenges as well as the agents and actors who provide diverse methods to provide solutions to global health threats [10]. Based on this gap, we define global health as multidisciplinary research that deals with the improvement of the health of every individual in the world through the collaborative efforts of governments, non-governmental organizations, and individuals who identify the causes of health threats that transcend national boundaries and recognize, respond to, and control known and unknown global health threats through the provision of population and individual-level clinical care and disease prevention actions, community education as well as large scale national or international interventions. From the definition above, it can be deduced that the field of global health is interdisciplinary in approach ranging from the field of medicine, public health, epidemiology, demography, psychology, sociology, and economics. The concept of global health is graphically depicted in figure 1.

The importance of global health cannot be underemphasized because it aims to improve the health of the world's population, maintain global security and provide equal access to healthcare services. However, global health is usually affected by public health threats and diverse events across the globe. Some of these threats, as identified by the World Health Organization [15], are discussed as follows:



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135 **Fig. 1. Depiction of global health**

136 **3.1 Air Pollution**

137 The World Health Organization [15] identified that about 90% of the world population inhale  
138 polluted air daily. The majority of these individuals are from low and medium income  
139 countries. Causes of air pollution include high volumes of emissions from vehicles and  
140 industries as well as burning of fossil fuels. According to the United Nations Economic  
141 Commission for Europe (UNECE), air pollution causes about seven million premature deaths  
142 annually [16].

143 **3.2 Climate Change**

144 According to World Health Organization [2], one of the major contributions to climate change  
145 is air pollution caused by burning fossil fuels. The emissions from the burning of fossil fuels  
146 results in global warming. This in turn leads to non-communicable diseases such as heart  
147 diseases, cancer and respiratory diseases [16]. Other causes of climate change include  
148 deforestation and oil drilling

149 **3.3 Non-Communicable/Non-Infectious Diseases**

150 According to Frumkin and Haines, non-communicable diseases contribute largely to the  
151 global burden of disease. Frumkin and Haines noted that about 70% of deaths across the  
152 globe can be linked to non-communicable diseases such as diabetes, cancer and heart  
153 diseases [17].

154 **3.4 Infectious Diseases and Pandemic**

155 According to the Center for Disaster Philanthropy, infectious diseases and pandemic are a  
156 sustained transmission of infectious diseases across international borders, countries, and  
157 continents [18]. The last two decades have experienced diverse pandemics due to  
158 international travel and trade, rapid urbanization, environmental degradation and limited  
159 access to healthcare. Typical examples of pandemics include the global influenza pandemic,  
160 Ebola, Zika and the ongoing COVID-19 currently threatening the lives of individuals across  
161 nations of the world.

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164 **3.5 Vaccine Hesitancy**

165 This refers to the delay in the acceptance of vaccines or the outright refusal of individuals to  
166 take vaccines in spite of their availability [19]. Vaccines prevent about 2-3 million deaths  
167 annually. Factors affecting the acceptance of vaccines include lack of confidence,  
168 inconvenience in accessing vaccines and complacency. About 2% of people living in  
169 developing countries have only received at least one dose of the COVID-19 vaccine despite  
170 the availability of the vaccine in these countries [20]. This makes the individuals in these  
171 countries and the world at large vulnerable to the disease.

172 **3.6 Inequality in Access to Healthcare Systems**

173 Some countries especially advanced countries, have healthcare systems that are affordable  
174 and easily accessible by their citizens, while most developing countries are characterized by  
175 healthcare systems that are weak, less developed and not easily accessible. The lack of  
176 access to quality healthcare services contributes to millions of premature deaths across the  
177 globe annually. However, the 1978 Declaration of Alma-Ata emphasized that the gross  
178 inequality in the health statuses of both developed and developing countries is politically,  
179 socially, and economically unacceptable [21].

### 180 **3.7 Shortage of Health Workers**

181 Health workers are the people whose major responsibility is to enhance people's health.  
182 They include doctors, nurses and midwives, pharmacists, laboratory technicians, community  
183 health workers and radiologists. There is currently a shortage of over seven million health  
184 workers across the globe [22]. Unfortunately, this situation is worsening as the World Health  
185 Organization projects that there will be a shortage of about eighteen million health workers  
186 globally by 2030 [23]. The shortage of health workers has negative impacts on the  
187 healthcare system. These include a high rate of child and maternal mortality, outbreaks of  
188 diseases, and a high rate of medical errors.

### 189 **3.8 Hunger and Starvation**

190 Hunger is the anguish associated with lack of food, while starvation is the severe deficiency  
191 in caloric energy intake. Hunger is one of the leading threats of global health in developing  
192 countries, as more than 650 million people were estimated to have been malnourished in  
193 2019 [24]. With the emergence of COVID-19, global hunger increased to about 720-811  
194 million people in 2020[25].

### 195 **3.9 Dengue**

196 This is a disease caused by a virus tagged dengue virus (DENV). It is however transmitted  
197 through the bite of an infected *Aedes aegypti* mosquito. It usually occurs in tropical and non-  
198 tropical regions, albeit the global incidence of dengue is estimated to be around 100-400  
199 million infections, with almost half of the world's population at risk of the disease [2].

### 200 **3.10 Weak Primary Healthcare**

201 Primary healthcare is the first level of contact healthcare practitioners have with people in a  
202 community to improve their health. It is usually affordable, comprehensive and community  
203 based. However, most countries lack adequate primary healthcare services.

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## 205 **4. ROLES OF ROBOTS IN IMPROVING GLOBAL HEALTH**

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207 The World Health Organization and several non-governmental organizations, governmental  
208 agencies, and individuals have played diverse roles in combating global health threats. For  
209 instance, the World Health Organization provides leadership roles in global health matters. It  
210 also establishes, supervises, strengthens and implements global health policies and  
211 practices. It engages in research of diseases and health policies that can be implemented on  
212 a global scale. It establishes evidenced-based science and ethical policies [26]. Despite the  
213 diverse roles of the World Health Organization, the world is struggling to tackle global health  
214 threats ranging from the outbreak of infectious diseases and pandemics, climate change, air  
215 pollution, and global warming. Consequently, the objective of this section is to address how  
216 robotic technology can deal with the problems created by global health threats. Hence, the  
217 applications of robots in global health are clearly highlighted below:

### 218 **4.1 Reduction in the Spread of Infectious Diseases and Pandemics**

219 With the upsurge in the number of infectious diseases and pandemic cases such as COVID-  
220 19 in recent times, there has been a remarkable demand for robots in the healthcare system  
221 [27]. The introduction of robots in the healthcare system protects frontline healthcare  
222 workers from getting exposed to infectious diseases and it also enhances self-isolation by  
223 reducing doctor-patient interaction. Robots such as the autonomous TUG robot have been

224 used to deliver food and medicines to patients in infectious disease wards. Robots are also  
225 used to clean and disinfect objects such as door handles and elevators, which are sources  
226 of transmitting infectious diseases. A typical example of a robot used in disinfecting objects  
227 is the UVD-bot. Another type of robot that reduces the spread of infectious diseases and the  
228 pandemic is the Wegree Robot which serves as a check-in staff for hospitals in order to  
229 reduce the physical interaction of healthcare workers with potentially infected patients [28].  
230 The UVD-robot and the Sayabot help to maintain social distance between health workers  
231 and their patients by taking temperature readings using a non-contact thermometer  
232 connected to the robot. Sayabot also helps in dispensing sanitizer to visitors [27]. Medical  
233 practitioners have also used mobile tele-presence robots with screens and touch screen  
234 interfaces in Italy to monitor COVID-19 patients without physically attending to them [29].  
235 Figure 2 shows some robots that can help to reduce the spread of infectious diseases.

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243 **Fig. 2. Some robots that help to contain the spread of infectious diseases [30, 31, 32]**

#### 244 **4.2 Assistance of inadequate healthcare workers**

245 The healthcare system globally is plagued with shortage of healthcare personnel. This  
246 affects the efficiency and the quality of healthcare services delivered by health workers. This  
247 results in an increase in the incidence of diseases and thus devastating economic situations.  
248 However, robots can assist healthcare workers in performing diverse roles, including  
249 dispensing drugs, taking patients' vital signs, lifting patients, drawing blood from patients,  
250 and performing surgeries. This reduces the workload of healthcare personnel, increases  
251 their efficiency, and reduces medical errors that could be caused by fatigue from heavy  
252 workload. Figure. 3 shows a robot drawing blood from a patient. This robot developed by  
253 Veebot can adequately identify the most accessible vein with an accuracy of 83%, which is  
254 as good as an experienced phlebotomist [33]. Robots have also been used to assist  
255 healthcare workers in surgeries. The advantages of surgical robots include increased  
256 precision of surgical manipulation, improved vision due to magnification, a more controlled,  
257 comfortable and safer environment and better ergonomic for the operator [34]. A good  
258 example of a surgical robot is the Da Vinci surgical system which is used to assist surgeons  
259 to perform delicate and complicated operations. Robots have also been used to provide  
260 support and companion to patients during the healing process and after recovery. A typical  
261 example of this robot is Paro.

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269 **Fig.3. Veebot robot drawing blood from a patient [33]**

270 **4.3 Reduction of Harmful Gases Released Into the Atmosphere**

271 The effect of climate change is felt by humans, animals, and plants. Some of the numerous  
272 effects of climate change are extreme temperature, global warming and adverse weather  
273 conditions, respiratory health disorder, flood and drought. One of the ways that robots can  
274 help in climate change is by reducing the amount of harmful gases introduced into the  
275 atmosphere. For instance, robots can be used in place of heavy duty manually operated  
276 machines that use fossil fuels and introduce carbon emissions into the environment.

277 **4.4 Food Security**

278 Research has shown that 820 million people do not get enough food to eat daily despite  
279 governments' efforts to end hunger and starvation globally [35]. Robots can be used to end  
280 hunger and starvation as well as achieve food security across all nations of the world. For  
281 instance, Saga (Swarm Robotics for Agricultural Applications), a swarm of drones, monitors  
282 weed infestations in the farm and checks the status of crops [36]. The R2Weed2 robot  
283 designed by Nexus Robotics is also used to differentiate between weeds and crops before  
284 removing the weeds amongst the crop on the field. In addition, Vegebot shown in Fig. 4. is a  
285 robot developed by Cambridge University for harvesting crops with precision and accuracy.  
286 Thereby reducing wastes that could have been caused by human errors such as harvesting  
287 of unripe fruits, tearing of leafy vegetables and bruising of fruits. Furthermore, Harvest Croo  
288 is a robot that is designed for harvesting crops that are prone to damages during the  
289 harvesting season, such as strawberries.

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**Fig.4.Vegebot [37]**



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304 **4.5 Reduction of anxiety and fear of vaccination**

305 The World Health Organization identified vaccine hesitancy as one of the greatest threats to  
306 global health [15]. The promotion of vaccination by health workers is usually weakened by  
307 weak counseling capacities, limited resources and lack of confidence in communication [38].  
308 Nevertheless, robots are used to boost vaccination rate and reduce anxiety before  
309 vaccination. For instance, the humanoid robot Pepper, as shown in Fig.5, is programmed to  
310 greet people waiting to be vaccinated and provide information about the vaccine [39].

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**Fig. 5. Pepper robot encouraging people to be vaccinated at Victoria University [39]**

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## **5. FACTORS AFFECTING THE EFFECTIVE USE OF ROBOTS IN COMBATING GLOBAL HEALTH THREATS**

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Robots have been deployed in diverse areas to help mitigate the effects of global health threats across the world, such as reducing harmful gases released into the environment, assisting healthcare workers in performing diverse tasks and combating hunger and starvation. Despite these benefits, various factors affect the effective use of robotic technology in combating global health threats. These factors, which include high cost of procurement, installation and maintenance, continuous power supply, fear of loss of job, usability issues, are discussed below:

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### **5.1 High Cost of Procurement, Installation and Maintenance**

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One of the challenges of using robots to mitigate the effects of global health threats is the rising cost of robots. This is because the cost of procurement, installation, configuration and maintenance of robotic systems are quite on the high side.

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### **5.2 Continuous Power Supply**

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Robots need continuous power sources to provide voltage signals that will make them function effectively. Such power sources include electrical, electromagnetic, thermoelectric, fuel cells, and super capacitors. The functions of robots become hampered if these power sources are inadequate or unavailable. These sources of power are also potentially damaging to the environment because they contribute to global warming and greenhouse gas emissions which contribute to global health challenges.

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### **5.3 User Acceptance**

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User acceptance refers to the willingness of a group of users to employ technology for the task it is designed to support as well as to integrate it into an environment based on the users' interaction, experiences, perceived usefulness of the technology and perceived ease of use. Hence, the deployment of robots to combat global health threats depends on how a particular country perceives the usefulness of the technology. For instance, robotic systems are highly accepted in Japan and Scandinavian countries, while countries in the Middle East are against the use of iconic technologies such as robots. Consequently, the use of robotic technologies to enhance global health is hindered in some nations.

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### **5.4 Fear of Displacement Of Job**

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One of the major challenges affecting the deployment of robotic systems is the fear that people will be displaced from their jobs and replaced with robots. This is because robots can work faster and for longer hours than human beings and at a cheaper cost. They can perform repetitive tasks without getting weary. The job insecurity created by the fear of job

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362 displacement by robots results in poor mental health, which is often linked with heart  
363 diseases and high mortality rates.

### 364 **5.5 Privacy Concerns**

365 Privacy, according to Laurinda, is the right of individuals to prevent their information from  
366 being revealed to others; the claim of individuals to avoid surveillance or interference from  
367 other individuals, organizations, or the government [40]. Robots cause privacy concerns  
368 because they can move around in the real world, gather data/ information and process data.  
369 Some robots record and transmit these data in human-readable format. Privacy concerns  
370 are raised when the user of a robot is not aware of what kind of data is collected, to whom  
371 the data is shared, and for what purpose the data is disclosed. Besides information privacy,  
372 robots can also violate other kinds of privacy, including personal space, territoriality, and  
373 solitude. Privacy concerns may lead to lack of confidence, transparency and trust in robotic  
374 systems, thereby reducing their acceptance rate in society.

### 375 **5.6 Interoperability Issues**

376 In simple terms, interoperability can be defined as the ability of two or more independent  
377 systems or components to exchange meaningful information reliably and quickly without  
378 errors [41]. Hence interoperability facilitates communication between two or more systems.  
379 Interoperability still remains a major challenge for effective communication among robotic  
380 systems. This is because robots are proprietary in nature. They are developed by different  
381 companies with a variety of hardware and software components. However, this makes it  
382 difficult for robots to easily share information, resulting in interoperability problems easily.  
383 Consequently, the lack of seamless, effective and meaningful exchange of information  
384 among robots of different brands can result in a collision between robots, leading to serious  
385 accidents.

## 387 **6. THE WAYS FORWARD**

388 The achievement of a world devoid of global health threat is a demanding task characterized  
389 by several barriers despite the numerous efforts of individuals, government of different  
390 nations, and non-governmental organizations. However, the following solutions can be  
391 adapted to facilitate the effective use of robots for combating global health threats:

### 392 **6.1 Adoption of a Common Standard for Robots of Different Brands**

393 One significant way of ensuring interoperability amongst diverse systems is the use of  
394 standards. Standards are established by consensus and approved by a recognized body to  
395 provide rules, guidelines, or characteristics for activities [40]. The adoption of a common  
396 standard for data exchange is essential for achieving complete interoperability amongst  
397 robotic systems.

### 398 **6.2 Education Strategy**

399 Government, non-governmental organizations and individuals should be taught the  
400 importance of robots in combating global health threats. Individuals should also be made to  
401 realize that using robots to perform their tasks is in their best interest in terms of time and  
402 professional convenience. People should also be educated that robots are designed to  
403 assist them and not to out rightly replace them in their jobs because they lack the human  
404 camaraderie required in workplaces.

### 405 **6.3 Capacity Building**

406 Individuals should be made to acquire the technical skills and knowledge needed to make  
407 full use of robotic systems to combat global health threats.

### 408 **6.4 Adoption of Greener Sources of Energy**

409 Greener sources of energy should be provided to power robots in order to reduce the effect  
410 of global warming and greenhouse emissions caused by other sources of energy such as  
411 electrical power sources, electromagnetic generators, thermoelectric generators, fuel cells  
412 and super capacitor.

### 413 **6.5 Privacy and Security Policies**

414 Robots should be designed to collect data from individuals in a lawful manner with the  
415 knowledge and consent of the owner of the data. In addition, the purpose for which the robot  
416 collects the data should also be communicated to the data owner. The data collected should  
417 be accurate and up-to-date and solely used for the purpose for which it is collected. The data  
418 must also be guarded against data loss, unauthorized access, destruction and modification.  
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## 420 **7. CONCLUSION**

421 Global health is an interdisciplinary research that deals with improving the health of all  
422 individuals of the world. It also deals with the identification of global health threats such as  
423 hunger and starvation, the spread of infectious diseases, climate change and air pollution,  
424 and how these threats are controlled by governmental and non-governmental organizations  
425 as well as individuals. Some of the ways individuals, governmental and non-governmental  
426 organizations control global health threats, include establishing global health policies and  
427 practices, evidence-based science, ethical policies, and research. Despite these efforts, the  
428 world is still struggling to deal with global health threats. Accordingly, this study explores how  
429 robots have been used to tackle the problems created by global health challenges such as  
430 reducing the spread of infectious diseases and pandemics, providing food security, reducing  
431 harmful gases released into the atmosphere, and reducing anxiety and fear of vaccination.  
432 The study also revealed some factors hindering the effective use of robotic technologies in  
433 combating global health threats. Such factors include privacy concerns, interoperability  
434 issues, fear of job displacement and high cost of procurement, installation and maintenance.  
435 The study suggests that adopting a common standard for robots of different brands,  
436 education strategy, capacity building and adopting greener sources of energy for robots are  
437 some ways to facilitate the effective use of robots for combating global health threats.  
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### 439 **COMPETING INTERESTS DISCLAIMER:**

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441 Authors have declared that no competing interests exist. The products used for this  
442 research are commonly and predominantly used products in our area of research  
443 and country. There is absolutely no conflict of interest between the authors and  
444 producers of the products because we do not intend to use these products as an  
445 avenue for any litigation but for the advancement of knowledge. Also, the research  
446 was not funded by the producing company rather it was funded by personal efforts  
447 of the authors.  
448

### 449 450 **AUTHORS' CONTRIBUTIONS**

451  
452 Author IO initiated and designed the study and wrote the first draft of the manuscript, Author  
453 IG wrote the protocol, Authors OO, IR and OJ managed the analyses of the study. All the  
454 authors managed the literature searches, read and approved the final manuscript.  
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