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THE IMPACT OF THE COVID-19 PANDEMIC ON THE RESEARCH AND DEVELOPMENT PROCESS OF GLOBAL LIFE SCIENCES COMPANIES

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ABSTRACT

Objective: The objective was to better understand the level of impact of the Covid-19 pandemic on the research and development process in global life sciences companies. The study was conducted with USA, Europe, and Turkey leaders.

Methods: This study was conducted with twenty functional leaders of leading global life sciences companies thru an online survey. The study was carried out between 2020 and 2021. The results were analyzed by using the Statistical 25 package.

Results: Research findings showed that there had been an impact on the research and development process of the life sciences companies, mainly the productivity and effectiveness. The primary issue was the lack of university collaborations. Although several therapeutic areas were somewhat impacted, cancer was mentioned as the most affected area due to the Covid-19 pandemic. Although the respondents indicated no change was done concerning research and development strategies due to the Covid-19 pandemic, most mentioned employing some new tools, such as remote patient monitoring. Additionally, the majority mentioned that their companies developed a crisis management plan.

Conclusion: The Covid-19 pandemic offered some challenges and opportunities to some life sciences companies. While the major challenge was to continue performing phase III trials, the significant opportunity was to develop vaccines and medical treatments for Covid-19ies.

Keywords: Covid-19 pandemic, pharmaceutical research and development, life sciences companies,

Introduction

The Covid-19 pandemic has created a major healthcare crisis globally. Therefore, governments had to take several serious actions to minimize the virus's spread and prevent deaths. These significant actions included the lockdown of entire cities, shutting down schools, shopping centers, and restaurants, forcing people to stay home and work from home, and switching to distance education. Furthermore, domestic violence, including physical, emotional, and sexual abuse, increased due to the Covid-19 pandemic (1, 2).

Several developed countries, such as the United States of America, the United Kingdom, Italy, and Spain, had to recruit retired health personnel to overcome the burden of the pandemic. The United States has contracted car and weapon manufacturers to provide ventilators for intubated patients (3). Due to a lack of resources, this pandemic especially challenged healthcare systems in low-and middle-income countries (LMICs). Even before the COVID-19 pandemic, healthcare systems in LMICs faced considerable challenges in providing high-quality, affordable, and universally accessible care (3).

The Covid-19 pandemic has dramatically changed outpatient care delivery; patient appointments have been postponed to minimize the transmission risk of the virus to either patients or healthcare workers. Physicians have switched from personal visits to distanced visits, especially in the UK and USA, whenever possible (4). It has become quite a challenge for chronic disease patients to keep up with their regular physician visits, check-ups, prescription refills, and follow-ups. There are obstacles to receiving treatment from healthcare personnel and facilities (3). Many patients were encouraged to stay at home and not to visit clinics and hospitals to reduce the risk of exposure (5).

The Covid-19 pandemic has also impacted the life sciences companies. The demand for the type and quantity of products was changed, regulations for diagnostic and treatment protocols were revised, the R&D process was affected, the industry slowed down, the drug approval process got delayed, and some emergency measures had to be considered about the supply chain (6). The pharmaceutical industry struggled to maintain market flow and access to vaccines to essential medicines at an affordable price (7).

Several life sciences companies had to face some issues, such as insufficient active pharmaceutical ingredients (APIs) supply prior to the Covid-19 outbreak that resulted in a lack of essential drugs supply while some others had a stockpile of APIs stored away; the companies either sold these supplies at extreme prices or refused to sell their supplies due to inadequate amounts in their stockpile (8). The pharmaceutical industry faced several challenges in managing the pandemic, including meeting the excessive demand for protective gear and diagnostic tests (9). Because China monopolizes the world's active ingredients manufacture (up to 60% of China's production), pharmaceutical companies had to rely heavily on compounds produced in China (10). The Covid-19 pandemic directly affected the shortage of medical supplies, supply-chain flow, logistics, and transport, as well as the shutting down of factories, especially in China, where most pharmaceuticals were from.

Background

Scientists have started working on numerous R&D projects to discover vaccines or medical treatment options for the Covid-19 pandemic. In addition to developing new vaccines, researchers identified several treatment options, such as dexamethasone, IL-6 blockers, and monoclonal antibodies, that could help reduce the mortality rates from the Covid-19 pandemic. Globally, 12 vaccines and four novel therapeutics for Covid-19 have been developed and approved, all in less than a year, with specific authorizations and timing variations. These novel treatments have been approved through emergency use authorizations in the face of the global pandemic, ensuring that the vaccines and treatments could reach patients as quickly as possible. Some vaccines were available only in the country they were developed or in geopolitically aligned locations, while others are more widely and globally available. While relatively few existing medicines have been shown to benefit Covid-19 patients in the trials completed so far, more than 60 previously approved medicines for other diseases were involved in trials to assess their efficacy for Covid-19 infections or associated symptoms (11).

FDA approvals of new drugs in 2021 also held steady. The agency approved 50 novel drugs in 2021, roughly in line with the 53 drugs that won approval a year prior. There were more than 5,700 drugs in the early-stage pipeline and over 3,200 in the late-stage pipeline, and while growth in the early-stage pipeline paused in 2020, the late-stage pipeline grew modestly. Total early-stage pipeline products declined by 13% in 2020, the first reduction since 2014, bringing the number of total products back to 2018 levels. In

the late-stage pipeline, products increased by 3% (11). Funding for research and development for early and late-stage R&D increased significantly in 2020, unaffected by the disruptions of Covid-19 and reflecting a strong focus on innovative pathways and approaches to discover and develop novel therapeutics. Strategic transactions – ranging from M&A through licensing and other forms of collaboration, often between large and small companies – also proceeded at typical levels, buoyed by a significant interest in Covid-19-related deals (11).

According to the findings of the study conducted with the R&D functional leaders by Mc Kinsey & Company in April 2020, more than 90 percent of the 34 companies reported that they had formally implemented the emergency procedures that were delineated under their business continuity plan, As of April 6, 2020, there were more than 2,850 trials and approximately 900,000 patients enrolled at trial sites in regions that were in partial or complete lockdown due to Covid-19 restrictions. Some surveys suggested that more than 50% of companies have paused recruitment for most trials, and 75% have paused site activation for most trials. The impact of the Covid-19 pandemic was somewhat not even in the therapeutic area. For example, other than oncology or some rare diseases, relatively less disruption had seen in other areas. Furthermore, regular daily operations were also clearly affected, as companies reported that R&D labs were operating below 50 percent of standard capacity. On average, reported adverse events have also fallen by between 0 and 10 percent. — Across all R&D-related groups, companies estimate productivity has fallen by between 25 and 75 percent due to remote working (12).

According to **Figure 1**, the therapeutic areas showing 100% major disruptions were gastrointestinal, inflammation, infectious diseases, and vaccines. No or low disruption was observed in the areas of rare diseases (50%), cardiovascular (50%), and oncology (20%).

In 2019 pharmaceutical companies spent an average of roughly 25% of their revenue on R&D, according to US federal government statistics. In 2021, top R&D spenders invested closer to one-fifth of their revenue in R&D (13). **Table 1** displays the top 20 life sciences companies regarding R&D spending.

The top three spenders were Pfizer, Roche, and Merck Co. Among 20 companies that allocate over 20 % of their sales to R&D were Vertex, Roche, Merck Co, Eli Lilly, BMS, Janssen, and Biogen. The largest pharmaceutical companies together spent more than $123 billion on research and development in 2020, up 12% from 2019 (13). Figure 2 displays the enormous pharma R&D spending as a percentage of their sales.

As shown in Figure 2, large companies steadily increased their share from 2014 to 2020. In 2020 percentage of sales increased to 20.4% from 19.3%. The total included the impact of acquisitions, for example, the Bristol Myers acquisition of Celgene. Across the companies, R&D exceeded 20% of revenue in 2020 for the first time (13).

Lastly, with the contribution effect of Covid-19 on the pharmaceutical industry, the industry shifted its attention to artificial Intelligence. Artificial Intelligence was beneficial for predicting Covid-19 spread and the incidence of infection. Artificial Intelligence can also be applied to the research and development of pharma industries. Computer-aided drug design can also improve R&D Labs (14).

In order to understand the level of impact of Covid-19 on the research and development operation of life sciences companies, the following issues were addressed in this global study.

- The most impacted areas of the research and development process due to Covid-19
- Actions/ strategies the life sciences companies had to implement due to Covid-19
- Opportunities and challenges the research and development department of life sciences companies had faced due to Covid-19

Methods

The descriptive method was employed in this study. The study was conducted thru an online survey with 20 functional leaders of the life sciences companies listed in Table 2. The ethical process within each company took longer than anticipated. The study took more than a year due to the company's lengthy internal procedure and difficulty reaching out to the correct department and proper respondents. The ethical committee approval was obtained from Toros University on August 20, 2020.

Despite several attempts made to each company listed in **Table 1**, only 14 companies

accepted to participate in this study (Table 2). In order to increase the number of companies, we included moderate R&D spenders in our study, and of those, we were only able to recruit four pharmaceutical companies. After each respondent signed the consent form that explained the purpose, scope, and confidentially, the survey was sent to the respondent.

Among the top 20 R&D spenders, Bayer, Takeda, Eli Lilly, Vertex, and Regeneron either wanted to refrain from participating or respond to our request for this study. Among the moderate R&D spenders we included in this study were Astellas (Turkey), Menarini (Europe), Alexion (Europe), Gensanta /Amgen (Turkey), Boehringer Ingelheim (Turkey), and Chiesi (Europe).

Data were analyzed by using SPSS 25 package. The significance analysis was done on a need basis, and the rest of the data were analyzed using frequencies in percentages and numbers.

Results

The socio-demographic characteristics of the respondents are provided in frequencies and numbers in **Table 3**.

Regarding socio-demographic variables of the respondents, half of the respondents were female, the respondents' age range varied from 40 to 60, only two respondents had a Bachelor's degree, and the rest had graduate degrees. Regarding profession, 12 respondents (60%) were medical doctors. Regarding the specialty area, six respondents (30%) were from clinical/ research operations. Half of the respondents indicated 1 to 5 years of experience concerning the length of employment in the current company. The years of experience in the related field reported by six respondents (30%) were between 16-20 years. Twelve respondents (60%) reported their companies as pharmaceuticals only.

Table 4 shows the department each participant worked within the company.

As displayed in Table 4, the respondents who participated in the study were mainly from medical or clinical/research departments. Seventeen respondents (85%) indicated their companies chose the combination of in-house and outsourcing as part of R&D operations. Concerning the percentage allocated to R&D from companies' gross sales, 60% mentioned that their companies allocate 16-20% to R&D from their gross sales. Table 5 shows the evaluation of R&D in terms of productivity, performance, effectiveness, and competitiveness on a 5-point scale, where 1= extremely low and 5=extremely high.

As summarized in **Table 5**, a statistically significant difference between the means of attributes prior to and after Covid-19 was obtained for Productivity and Performance of R&D ($p<0.05$), meaning the Covid-19 Pandemic significantly impacted these two. Although there was a difference in the means of attributes regarding Effectiveness and Competitiveness before and after the Covid-19 pandemic, this difference was not statistically significant. Respondents were asked what type of issues the R&D departments struggled with; the responses to that question are shown in **Table 6**.

Table 6 shows six respondents (31.5%) chose "lack of collaboration with universities." Regarding R&D strategies, nineteen (95%) respondents reported that their companies have developed R&D strategies. Regarding the therapeutic area of focus, thirteen (57%) respondents mentioned their companies focused on only medicine, while six respondents (30%) reported medicine and vaccine together. **Figure 3** shows the therapeutic areas of focus.

As seen in **Figure 3**, fifteen respondents (75%) chose "cancer and autoimmune diseases" as one of the top therapeutic areas of focus. Concerning the level of impact of Covid-19 on R&D, nearly half of the study respondents mentioned that the R&D function had been impacted, and 7 (35%) respondents mentioned that the R&D function of their companies has neither been impacted nor unimpacted. Respondents were asked about the targeted number of new drug applications for 2020 that was determined before the Covid-19 pandemic. Twelve (66.7%) respondents chose the 1-5 range, and 3 (16.67%) respondents reported the targeted new drug applications as being between 11-15. Among all therapeutic areas, cancer was mentioned as the most affected (33% of respondents), followed by respiratory diseases (10%). Five respondents chose "50 and above" concerning the targeted total number of ongoing phase III projects for 2020 before the Covid-19 pandemic. According to most respondents, the targeted R&D budget for 2020 was determined as 1-4 billion USD. Regarding R&D employees per R&D site before the Covid-19 pandemic, more than 500 employees were mentioned by about 78% of respondents.

When assessing the level of impact of Covid-19 on the number of employees per site, 85% of the respondents indicated no impact on the number of R&D employees per site. Table 7 displays the level of impact of Covid-19 on the R&D process.

According to **Table 7**, the R&D process and budget had been impacted by the Covid-19 pandemic on a moderate level. However, the number of R&D employees per site has not been impacted. Table 8 summarizes the distribution of responses related to the steps taken by the companies in response to Covid-19.

According to **Table 8**, thirteen respondents (65%) chose “increased R&D efforts towards medical treatment.” Ten respondents (50%) chose “keeping the R&D budget unchanged.” In response to the Covid-19 pandemic, the respondents were asked what actionable steps their companies had to choose to follow. The responses to this question are displayed in **Table 9**.

Among the statements listed in **Table 9**, numbers 3 and 4 were selected by 50% of the respondents. Based on the responses, companies developed a crisis management plan and new R&D tools as an action plan in reaction to the Covid-19 pandemic. Respondents were asked how the Covid-19 pandemic impacted ongoing clinical studies; the responses are shown in **Table 10**.

Table 10 shows that eleven respondents (57.89%) chose “clinical trials were on schedule.” Seven respondents (36.84%) chose “clinical trials were postponed.” Due to the Covid-19 pandemic, the respondents were asked what type of R&D tools they used as an open-ended question. The responses are shown in **Table 11**.

Table 11 shows five respondents (25%) mentioned using remote patient monitoring tools, but nothing specific was mentioned. Lastly, the respondents were asked whether the company she/he worked for had to change its R&D policy and strategy due to the Covid-19 pandemic. Fifteen (75%) respondents mentioned that their companies kept the same strategy.

Discussion and Conclusions

As with any study, the limitations must be considered to correctly interpret the results. In this study, limitations arise from two perspectives. The first perspective was the responses to the questions based on top-of-mind knowledge. The second perspective was the inadequate number of participants. As we all know, the pharmaceutical industry is highly R&D intensive. On average, across the OECD countries, the industry spent nearly 12% of its gross value on R&D (15). In this study, 12 respondents (60%) said that the pharmaceutical company she /he worked for allocated 16-20% of the gross sales of their companies to R&D.

Half of the study respondents indicated that the Covid-19 pandemic impacted pharmaceutical R&D. The measures impacting R&D evaluated were productivity, performance, effectiveness, and competitiveness. Among those, only productivity and performance were significantly impacted by the Covid-19 pandemic. These findings were consistent with the McKinsey report (12). In this study, the main issue, among all others, was the lack of collaboration with universities. According to the study conducted with international and domestic pharmaceutical companies located in Turkey, the medical or clinical research leaders stated that they collaborated with universities located in Turkey and /or outside of Turkey. (16).

In this study, most respondents indicated that their companies allocated 16-20% of their gross sales budget to R&D. This finding was in line with the Drug Discovery Reports (13). Concerning the most affected therapeutic area by the Covid-19 pandemic among all the others, cancer stood out as the top area in this research. However, in another study conducted by McKinsey, the respondents mentioned cancer as one of the areas that observed modest disruption when it comes to clinical studies (12). In this study, most respondents mentioned that R&D operation had been done thru inhouse or external contractors. According to another report, drug discovery productivity depends on the internal organization of R&D. For these reasons; pharmaceutical companies have been forced to reassess their model of R&D operation, including outsourcing activities (17, 18, and 19).

Furthermore, the complementarity between in-house R&D and external know-how creates additional benefits regarding the quality of research and services. Therefore, the right strategic partner could offer cost advantages, quality improvement, and innovation, and the "strategic partnership" model guarantees a high internal competence level in the long term (19). In order to measure the impact level of the Covid-19 pandemic on R&D, the following assessments were made in the areas: a new number of drug applications, the R&D budget, and the number of ongoing phase III projects. All these areas were impacted on a moderate level. Regarding the Covid-19 impact on the number of R&D employees, most respondents did not see any impact on the number of R&D employees per site.

In general, the R&D leaders pointed out that their companies developed a crisis management plan in response to the Covid-19 pandemic. In the Mc Kinsey report, the R&D leaders said they had to spend an average of 40 to 50 percent of their time on crisis management. The figure rose as high as 80% for CMOs and other medical leaders who were members of company disaster response teams (12). Concerning the R&D tools that had to be used due to Covid-19 pandemic, 25% of the respondents mentioned remote patient monitoring tools. According to the industry survey conducted by the ALMAC group in June 2020, 41% of respondents said that accelerated technology adoption to allow virtual interactions with patients had already impacted their clinical development model. It was clear that other modifications, such as protocol design modifications and stricter site evaluation criteria, were also being made to try and allow the continuation of clinical trials within the changing environment (20). The findings revealed that the lack of university collaborations was the central struggle of global life sciences companies' R& D departments. The reasons for this lack of collaboration were not explored in this research. However, the qualitative research study conducted with global pharmaceutical companies in Turkey revealed the lack of collaborations. The main reason for this was the difference in the expectations of the outcome of the research collaborations. While the academic staff wanted to publish more, pharmaceutical companies defended the confidentiality of the research (16).

In conclusion, the Covid-19 global pandemic was associated with short- and long-term impacts on the healthcare industry, including the pharmaceutical sector, from both global and local levels. Although the pharmaceutical R&D operation had been impacted in general, some life sciences companies were able to shift their R&D focus to the development of vaccines and medical treatment of Covid-19. For future reference, R&D departments would be utilizing patient remote monitoring tools, artificial intelligence, and digital health data to minimize the impact of pandemics on R&D operations. Although many global life sciences companies were partnered in the co-development of innovative medicines with universities, there is room for improving collaborations.

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Conflict of Interest
No conflict of interest was reported.

Funding
No funding was obtained

Ethical Considerations
All ethical considerations were taken into account.

Tables

Table 1. Top 20 R&D spenders, 2021

No	Company	R&D spend (Billion in USD)	RD as a percentage of revenue (%)
1	Pfizer	13.8	17
2	Roche	13.3	27
3	Merck &Co	12,2	25
4	Janssen	11.8	22.8
5	BMS	11.3	24.5
6	Astra Zeneca	9.7	26
7	Novartis	9.5	18.5
8	AbbVie	7.0	12.6
9	Eli Lilly	7.0	24.8
10	Sanofi	6.7	15
11	Glaxo Smith Kline	6.5	14
12	Gilead	5.3	19
13	Amgen	4.8	18.5
14	Takeda	4.1	14.3
15	Bayer	3.7	17
16	Vertex	3.0	40
17	Regeneron	2.9	18
18	Novo Nordisk	2.8	12.6
19	Biogen	2.5	22.8
20	Merck KGaA Germany	2.4	12.8

Table 2. Top pharma research and development spenders participated in the study

No	Company	Location
1	Pfizer	Turkey
2	Roche	Europe
3	Merck &Co	Turkey
4	Janssen	Turkey
5	BMS	Turkey
6	Astra Zeneca	Turkey
7	Novartis	Europe
8	AbbVie	USA
9	Sanofi	Turkey
10	Glaxo Smith Kline	Turkey
11	Gilead	Turkey
12	Amgen	Turkey
13	Novo Nordisk	Turkey
14	Merck KGaA Germany	Turkey

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Table 3. Socio demographic characteristics of respondents

Variable *Total Respondents: 20*	*%*	*n*
Gender		
Female	50	10
Male	50	10
Age		
21-25	0	0
26-30	0	0
36-40	10	2
41-45	30	6
46-50	25	5
51-55	25	5
56-60	10	2
60 above	0	0
Most recent degree		
Bachelor's	10	2
Master's	45	9
Doctorate	40	8
Other	5	1
Profession		
Medical doctor	60	12
Pharmacist	10	2
Chemical Engineer	0.5	1
Biologist /Molecular biologist	10	5
Area of specialty		
Cardiology	0.5	1
Clinical research /operations	30	6
Pharmacology	0.5	1
Internal Medicine	10	1
GP	10	2
Pulmonology	10.	2
OB/GYN	0.5	1
Infectious disease /Clinical Microbiology	0.5	1
Neurobiology	0.5	1
Value added R&D/Biosimilars	0.5	1
Internal Medicine/Oncology	0.5	1
Molecular biology	0.5	1
Years of experience in the current company	0	0
1-5	25	5
6-10	25	5
11-15	20	4
16-20	20	4
21-25	10	2
26-30	0	0
31 and above		
Years of Experience in the related field		
1-5	0	0
6-10	10	2
11-15	20	4
16-20	25	5
21-25	30	6
26-30	10	2
31 and above	0.5	1
What type of company do you work for?		
Biotech only	10	1
Pharma only	60	12
Pharma and biotech	35	7

Table 4: Area of specialt

#	Area of Specialty
1	Cardiology
2	Country Operations, EMA, ROW
3	Medical Department
4	Clinical Operation
5	Medical Department
6	Medical Department
7	Clinical Research Department
8	Medical Department
9	Medical Affairs
10	Medical Department
11	Medical Affairs
12	Clinical Research
13	Clinical Operations
14	Immunology Clinical Development
15	Global Operations
16	Clinical development Center
17	Technical Operations
18	Global Medical Affairs
19	Clinical Study Unit
20	Clinical Operations

Table 5: Evaluation of R&D operation

		Mean	z	p*
Productivity	Prior to Covid-19 Pandemic	4.20±768	-1.941	**.049**
	During Covid-19 Pandemic	3,85±671		
Performance	Prior to Covid-19 Pandemic	4.20±768	-2.309	**.021**
	During Covid-19	3,80±696		
Effectiveness	Prior to Covid-19 Pandemic	4,20±696	-,973	.331
	During Covid-19 Pandemic	4,00±,858		
Competitiveness	Prior to Covid-19 Pandemic	4,05±759	-1.513	,130
	During Covid-19 Pandemic	3,7±5910		

P<0.05

Table 6: R&D Issues

Issues	n	%
Lack of funds	2	10.5
Lack of capabilities	2	15.7
Lack of vision	1	5.2
Lack of portfolio	2	10.5
Lack of collaborations with universities	6	31.5
Lack of strategies /planning	1	5.2
Others	9	47.3

Table 7: The level of impact of Covid-19 pandemic on R&D process

	n	Min	Max	Mean	Std. Deviation
Covid-19 impact on number of ongoing phase III projects	19	0	70	38,32	21.174
Covid-19 impact on number of new drug applications	17	0	90	32,65	26.220
Covid-19 impact on R&D budget	18	0	75	33,06	22.985

Table 8: Responses regarding the company's action plan

Statements	n	%
Increased our R&D budget	3	15
Increased number of clinical studies	3	15
Increased R&D efforts towards vaccine development for Covid-19	6	30
Increased R&D efforts towards medical treatment for Covid-19	13	65
Decreased R&D budget due to Covid-19 impact	0	0
Decreased R&D efforts due to Covid-19	0	0
Kept the R&D budget unchanged	10	50
Kept the R&D efforts unchanged	8	40

Table 9: Responses given to each statement

#	Statements	n	%
1	Company has decided to reduce the number of R&D employees	1	5.56
2	Company has decided to shutdown R&D centers in some countries	0	0
3	Company has developed a crisis management plan	10	55.56
4	Company has started using new R&D tools	9	50
5	Company has decided to reduce the number of R&D projects	0	0
6	Company has decided to outsource R&D programs	1	5.56
7	Company has decided to shift the focus of interest	3	16.67

Table 10: The impact of Covid-19 pandemic on ongoing clinical studies

Statements	n	%
Clinical trial programs are discontinued	0	0.0
Clinical trial programs are redesigned	4	21.05
Clinical trials are on schedule	11	57.89
Clinical trials are postponed	7	36.84
Number of clinical trials is reduced	0	0.0
Other	8	42.11

Table 11: R&D tools used during Covid-19 pandemic

Statements	n	%
Remote patient monitoring tools	5	25
Home visits, sending products to patients	3	15
New Guidance for Covid-19 to manage crisis	1	5
More effective and innovative usage of RW Data and Data Science	1	5
Home care services	1	5
Decentralized trial replacement	1	5
Artificial intelligence	1	5
Digital health	1	5
Others	5	25

Figures

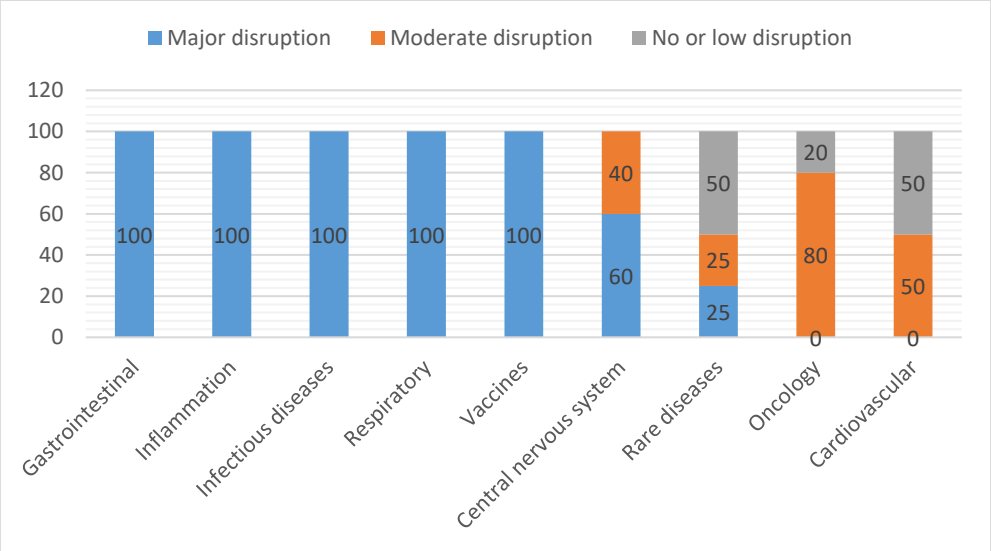

Figure 1. The level of disruption varying by therapeutic area
(Reported disruption level of clinical trials, by therapeutic area, % of respondents)

Flow disruption is defined as <10% slowing to the overall development timeline; moderate disruption as 10%–30% slowing to the overall development timeline; significant disruption as >30% slowing to the overall development timeline.
Source: McKinsey Clinical Operations Survey (Apr 6, 2020, n = 8) (12)

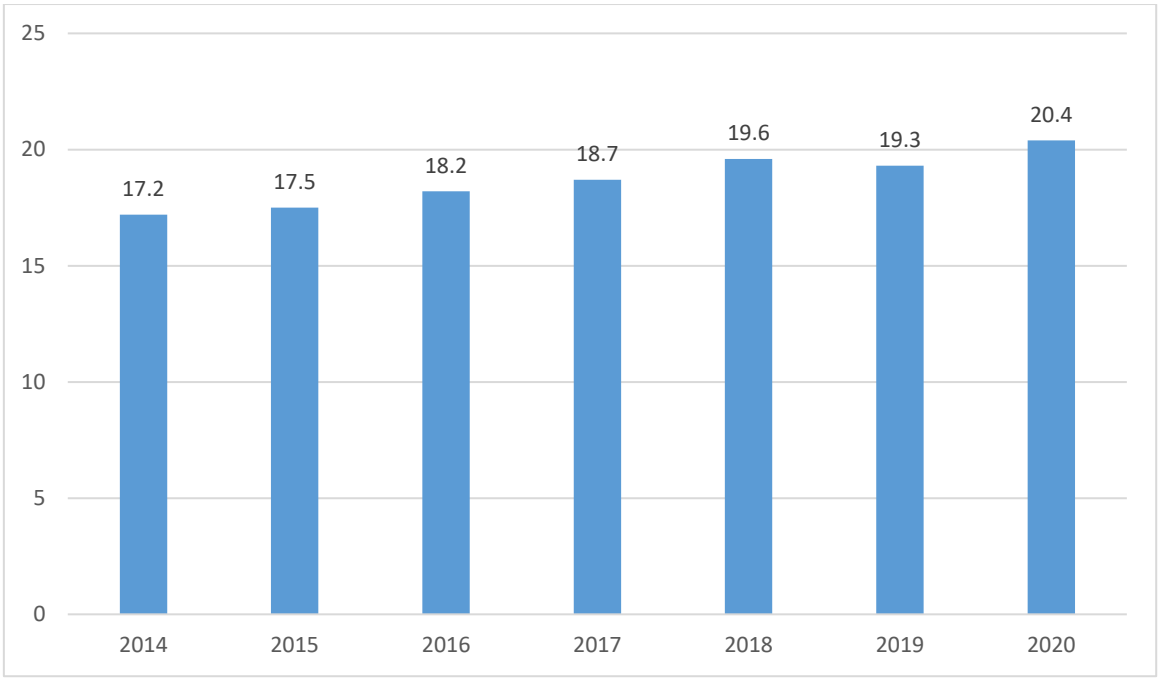

Figure 2. Large pharma R&D spending as a percentage of sales 2014-2020
Source: www.drugdiscoverytrends.com/pharmas-top-20-rd-spenders-in-2021 (13)

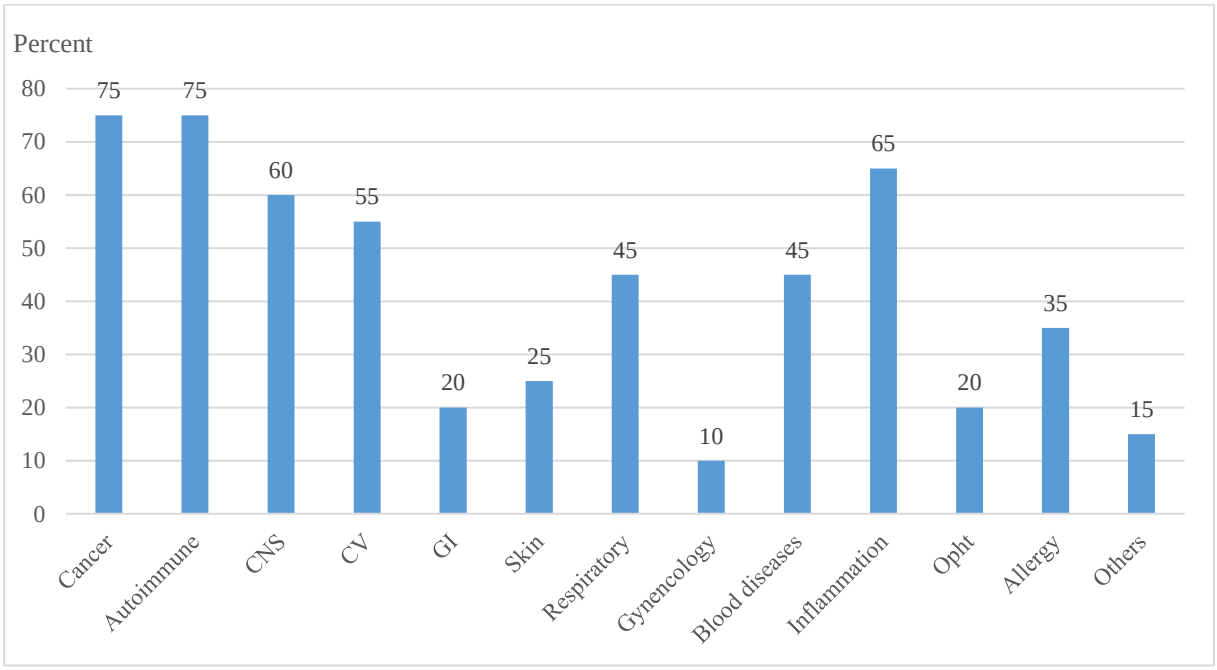

Figure 3. Therapeutic areas of focus

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