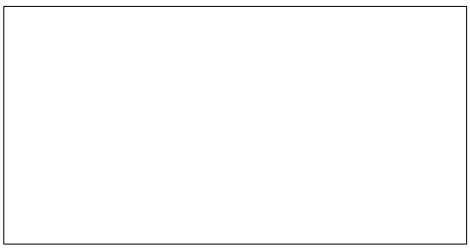

How COVID-19 has affected research productivity in Africa: Lessons for the Future

Abstract:
The first wave of the COVID-19 pandemic, and the resulting closures, shift to online teaching, and working from home had an impact on the scientific research sector. There is strong evidence that suggests that some researchers fared far worse than others. The purpose of this paper is to investigate how the pandemic has differentially affected the productivity of researchers from different backgrounds and showcase the factors that are responsible for these inequalities. Data for this study were collected using an electronic questionnaire via Qualtrics, distributed to researchers across Africa. 311 Participants completed the questionnaire in August/September 2020. Our results show that although overall time spent working during COVID-19 has increased, this has not translated into enhanced levels of productivity. Researchers are spending about 22 hours per week extra working than before the COVID-19 pandemic hit. Male researchers were able to spend more time on publications, patents, and consulting activities than their female counterparts. Our findings show that the lack of access to "on-site" research activities was a major factor that affected research productivity. In essence, there is a need to design practices that will facilitate the development of novel procedures for carrying out those activities in a socially distant way.

Keywords: Africa; Covid-19 pandemic; Gender; Research productivity; Workload

1. Introduction

The first cases of the coronavirus disease 2019 (COVID-19) caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) were first reported in China by the World Health Organization (WHO) on 31 December 2019 (World Health Organisation, 2020). The first confirmed case in Africa, found in Egypt, was not until 14 February 2020 (Makoni, 2020). Since then, the number of confirmed cases on the continent has continued to rise. As of 20 May 2021, the continent had more than 4.7 million symptomatic cases and over 127,000 deaths (Statista, 2021). It is believed that this is a conservative estimate because of limited COVID-19 testing and reporting capacity across Africa (Sun, Dickens, Cook, & Clapham, 2020).

Although the main impact of COVID-19 is on individual health through contagion, there have been other consequences as a result of preventive measures adopted by various governments and organisations to curtail its spread (Paolini & Vivarelli, 2021; Scherbina, 2021). Some of the measures have included the locking down of countries' boundaries, partial or complete lockdown of economies, especially businesses, schools, churches, and some social services. What used to be normal, has given way to a new normal which is new ways of doing things in almost all the socioeconomic sectors (business, education, health, industrial, and some other social services) globally. According to Hedding, Greve, Breetzke, Nel, and Van Vuuren (2020) this signals the end of the way we do things as we know it. In terms of planning for the future, we not only need to understand COVID-19 impacts but also use that understanding to plan for possible long-lasting changes in the workplace.

Although COVID-19 is a recent and ongoing global health crisis, emerging studies have presented compelling evidence on the many ways the pandemic has impacted work in various sectors. Alsharef, Banerjee, Uddin, Albert, and Jaselskis (2021) describe how the pandemic has led to adverse effects such as significant delays on projects, inability to secure materials on time, reduction in productivity rates, and, material price escalations. It can also create new opportunities such as fast-track construction of medical facilities, construction of residential buildings, transportation-related work, and opportunities to recruit skilled workers in the construction sector. Arntz, Yahmed, and Berlingieri (2020) highlighted that working from home provides women the opportunity to catch up with their male counterparts. Yet, the need to simultaneously care for children during the COVID-19 lockdown may potentially counteract such gains.

The scientific research sector has been impacted by COVID-19 in several ways (Collins, 2020) because the pandemic has disrupted how researchers carry out their activities. Equally important to note is that the pandemic has provided the scientific research sector with opportunities such as paving the way for introducing online research and stimulating new and fast-growing interest in different research areas (Amano-Patiño, Faraglia, Giannitsarou, & Hasna, 2020). On the other hand, the pandemic has arguably brought with it the largest disruption of scientific research activities in human history, affecting the 7.8 million full-time equivalent researchers in the world (UNESCO, 2015). Emerging studies have highlighted some of the ways that the COVID-19 pandemic has impacted the work of scientific research to include curtailment of collegial relations (van Schalkwyk, 2020), the challenge of balancing home-schooling with sustaining research work due to restrictions in laboratory access, and on conducting fieldwork (Eaton, 2020). There is also strong evidence that suggests that the pandemic is not impacting everyone

the same way (Etheridge, Tang, & Wang, 2020). Schotte, Danquah, Osei, and Sen (2021) went as far as suggesting that the COVID-19 pandemic has the potential of accentuating existing inequalities. Studies have shown that the lockdown is entrenching traditional gendered inequalities (Arntz et al., 2020; Cui, Ding, & Zhu, 2020; King & Frederickson, 2021; Yildirim & Eslen-Ziya, 2021). In their study of the United States, Cui et al. (2020) found that female academics' productivity dropped by 13.2 percent relative to that of male academics. Eaton (2020) suggests the pandemic has disproportionately affected the productivity of early-career researchers. Yet, some other studies have highlighted how the pandemic has disproportionately impacted research institutions in Africa (Hedding et al., 2020; Mugo, Wachira, & Odera, 2021).

There is no doubt that the COVID-19 pandemic has changed the way researchers work with important implications for productivity. As the pandemic recedes and going forward, researchers will need to learn to work with some changes to research working practices. This is not only because of the long-term impacts of COVID-19 but because we are not immune to a reoccurrence of similar incidences in the future. Therefore, a key research policy issue, is how these changes in research working practices impact productivity. Understanding how COVID-19 has affected the productivity of researchers could contribute to policies that should help mitigate productivity-decelerating effects of changes in research working practices and enhance the influence of productivity-accelerating factors (di Mauro & Syverson, 2020).

Yet, insights into how the pandemic has impacted the productivity of researchers are still sketchy in the broader literature. Furthermore, most of the existing studies focus has focused on researchers in western countries (see (Cui et al., 2020; Myers et al., 2020), leaving major gaps in our understanding of how Africa's centers of knowledge production, which are to some extent more vulnerable, are faring in this crisis. As such, there have been calls for more studies to focus on how the pandemic has affected the research sector in Africa (Mugo et al., 2021; van Schalkwyk, 2020). It is also unclear how socio-demographic factors (such as location, gender, age) have influenced the productivity of researchers working in Africa. These are the gaps that this paper seeks to fill. Therefore, this research was conducted to assess the effect of COVID-19 on the productivities of African researchers and to understand the key socio-demographic factors behind these. To do this, we make use of survey data collected through an electronic questionnaire via Qualtrics, distributed to researchers across Africa.

The findings could be useful as research institutions continue to combat the pandemic and grapple with preserving research integrity and maintaining productivity. This will enable more directed and development-focused ways of assisting African researchers to be competitive in the committee of nations. The findings can also serve as a resource for the future if the sector encounters similar epidemics, pandemics, or emergencies, which are often more commonplace in Africa than in other regions.

2. Research Productivity

The development of research capacity is considered a fundamental factor in national development (Abramo & D'Angelo, 2014; de Almeida, Ernica, & Knobel, 2020; Nchinda, 2002; Sawyerr, 2004) not least because it helps in closing the evidence-practice gap (Cooke et al. 2018). As such research capacity is a key aspect of an educational and research institution. On the individual level, educational and research institutions often seek to measure employees'

research performance or productivity using metrics like publications per researcher though this is a simplistic and non-universal approach of doing so (Abramo & D'Angelo, 2014). A broader definition is that research productivity entails "a production process in which the inputs consist of human, tangible (scientific instruments, materials, etc.) and intangible (accumulated knowledge, social networks, economic rents, etc.) resources, and where the output, the new knowledge, has a complex character of both a tangible nature (publications, patents, conference presentations, databases, etc.) and intangible nature (tacit knowledge, consulting activity, etc.)" (Abramo & D'Angelo, 2014: 1131). This definition provides clarity not just on how to measure research productivity but also provides us with indicators for identifying research productivity. In the context of this study, productivity is measured in terms of conference attendance/presentations (including virtually), consulting activities, using, searching and development of databases (e.g. Microsoft Access, Oracle Database, Microsoft SQL Server, Amazon Relational Database etc, henceforth referred to as database), editorial/review duties, grant applications, patents, publications, and acquiring tacit knowledge (tactic knowledge is nonverbalized, intuitive and unarticulated knowledge e.g. personal wisdom, experience, insight and intuition).

Several factors that shape outcomes of research productivity have been identified in literature (Chen, Gupta, & Hoshower, 2006; Fox & Faver, 1984; Lockwood, Jordan, & Kunda, 2002). A more recent study by Mantikayan and Abdulgani (2018) provides a comprehensive list of the factors that can affect research productivity the ascriptive (such as age and personality of the researcher); institutional (such as staff support and rewards); individual (such as affiliation and scholarly pursuit) and leadership factors (such as research orientation). For this study, the project team has purposively selected the factors regarded as essential for inclusion in the questionnaire. Our focus was more on the ascriptive and institutional factors. We are conscious that we have not included the wide range of factors that can shape research productivity.

3. Method

To better investigate the perceptions of African researchers on the impacts of the COVID-19 pandemic on their research productivity, primary data was collected using Qualtrics, an online survey data collection platform. The online survey was randomly distributed to research professionals using diverse online platforms from 5th August to 5th September 2020.

The study population comprised all researchers within academic and allied institutions whose core working area is the African continent irrespective of their discipline. The link to the questionnaire was distributed and shared by the project team members across numerous national and regional platforms (through WhatsApp, Facebook, and Email) of academics, professionals, and alumni associations. Project team members shared the questionnaire on national platforms used by researchers in all African countries. The survey was a web-based anonymous survey that did not ask respondents to provide any kind of identifiable personal information. Full ethics approval was sought and granted for this study. Informed consent was given before each participant completed the survey. Participants were notified that they could withdraw at any point of the study.

The questionnaire went through three rounds of review and pretesting. The final version of the questionnaire had 27 questions in 6 sections. Section 1 collected general information about the

participant (e.g. gender, marital status, and the number of dependents). Section 2 focused on participants' organisation and their role (e.g. kind of organization, position, and contract type). In section three, the questionnaire collected information on participants' activities during the pandemic (e.g., if their workplace was closed during the COVID-19 pandemic) while section four focused on research productivity before and during the pandemic (e.g., number of hours per week spend on each productivity activities). To avoid the limitations of the closed-ended and Likert scale questions, and allow respondents to express views not covered elsewhere in the questionnaire, the final section was an open-ended question which asked respondents to add any comments they might have about the topic. Occasionally, closed-ended questions included an "Other: please specify" option to allow respondents to add to the choices suggested in the actual question.

Over the four weeks for which the survey was open, 356 questionnaires were returned. Subsequently, we cleaned the data by identifying and removing incomplete responses. In the end, we were left with 311 completed questionnaires on which analysis was based. The data from Qualtrics was downloaded into Microsoft Excel and analysed using Statistical Package for Social Sciences (SPSS). Three main types of tests were conducted. A correlation analysis was used to assess the relationship between independent variables and research productivity. The one-way mixed-model ANOVA test was used to assess differences in mean categories and research productivity. As the study comprised many variables as well as many groups among each variable, the ANOVA technique was used. The H_0 (null hypothesis) is stated as: 'there is no difference in means between research productivity and socio economic, organisation and COVID-19 related variables[1]'. If any of these effects were significant at the 95% level, the multiple regression analysis was used to test the significant variables as a predictor of research productivity during COVID-19.

The Pearson's correlation is employed to examine the relationship between continuous independent variables and research productivity. Correlation coefficients can provide a numerical overview of the direction and strength of the linear relationship between the continuous independent variables and research productivity. Pearson's correlation coefficients (r) range from -1 to +1 for the indication of positive or negative correlation. The findings of the correlations between the independent variables and the dependent variable (research productivity) are presented in section 4.8.

4 Results

4.1 Socioeconomic Characteristics of Respondents

The summary of the socioeconomic characteristics of the survey respondents who are researchers and scientists drawn from 19 countries[2] across the African continent is presented in Table 1. The respondents were characterized using sixteen variables namely gender, age, number in a household, number of dependents, marital status, educational level, kind of organization, current

[1] Gender, Age, Marital Status, Educational level, Kind of organisation, Research position, Contract type, Closure of organisation dur to COVID-19, Working out of office due to COVID-19, Effect of COVID-19 on income, Effect of COVID-19 on workload, Effect of COVID-19 on mental health, Mental health support by employer for COVID-19.

[2] Algeria, Benin, Cameroon, Egypt, Eswatini, Ethiopia, Ghana, Kenya, Liberia, Madagascar, Malawi, Mozambique, Nigeria, South Africa, Tanzania, Togo, Uganda, Zambia, Zimbabwe.

research position, years of experience, contract type, organisation closed due to COVID-19, work out of office due to COVID-19, the effect of COVID-19 on income, the effect of COVID-19 on mental health, and mental health support by an employer for COVID-19. In more than half of the variables we received complete responses from 311 respondents with the number of respondents varying for the remaining ones. Of our 311 respondents, 55% were females and the majority of respondents (30.9%) were within the age range of 35-44. Even though 63% of respondents' household population ranges between 1-5 persons, 74.6% of respondents had between 0 – 4 dependents. However, 64% of respondents were married. Forty-two percent (42.1%)of respondents had attained a master's degree level while 36% were doctorate degree holders. Most of the respondents (76%) belonged to various academic or research institutes. In terms of the respondents (36.8%) were university lecturers. Nevertheless, most of the respondents (34.7%) had research experience of between 0 – 4 years, with 56.3% of respondents being on a permanent and full-time contract. Most of their organizations (74%) closed due to the COVID-19 pandemic and, as such, the results show that 72.7% of our respondents worked out of office due to the COVID-19 pandemic. Fifty percent (50.2%) of respondents demonstrated that the COVID-19 pandemic neither reduced nor increased their income. Unfortunately, 46% of respondents noted that their income was reduced by the COVID-19 pandemic. Although 44.1% of respondents experienced a reduction in workload due to the pandemic, more than half of the respondents (50.1%) did not experience COVID-19 related mental health issues. Nevertheless, more than a quarter of the respondents (29.2%) felt both partially and negatively affected in their mental health due to COVID-19. Unfortunately, 83% of respondents expressed that they received no mental health support from their employer for COVID-19. This is partly because mental health services throughout Africa are poor (Sankoh, Sevalie, & Weston, 2018).

Table 1 about here: Summary statistics of the socioeconomic characteristics of the study population

4.2. Gendered Dimension to Research Productivity by Scientists in Africa

Table 2 shows there were increases in the level of productivity of both female and male researcher scientists in Africa in terms of the hours/weeks spent on publications, patents, conference attendance/presentations (including virtually), grant applications, databases, tacit knowledge, consulting activities and editorial/review duties before and during the COVID-19 pandemic. The hours/weeks spent on these activities increased during the COVID-19 pandemic than before. Female academics in Africa spent 4.79hrs/week on publications, 0.56hrs/wk on patents, 5.23hrs/wk on conference attendance/presentations (including virtually), 1.35hrs/wk on grant applications, 4.47hrs/wk on databases, 3.11hrs/wk on acquiring tacit knowledge, 1.23hrs/wk on consulting activities, and 0.25hrs/wk on editorial/review duties more during COVID-19 pandemic than before the pandemic. Similarly, male academics in Africa spent 0.92hrs/week on publications, 5.51hrs/wk on patents, 6.13hrs/wk on conference attendance/presentations (including virtually), 3.69hrs/wk on grant application, 0.44hrs/wk on databases, 2.69hrs/wk on acquiring tacit knowledge and 5.66hrs/wk on editorial/review duties more during COVID-19 pandemic than before the pandemic but spent 0.55hrs/wk less on consulting activities during COVID-19 pandemic than before. In sum, academics in Africa spent more time on productivity during the COVID-19 era than before: 2.86hrs/week on publications, 3.04hrs/wk on patents, 5.68hrs/wk on conference attendance/presentations (including virtually), 2.51hrs/wk on grant applications, 2.45hrs/wk on databases, 2.89hrs/wk on acquiring tacit

knowledge, 0.33hrs/wk on consulting activities, and 2.96hrs/wk on editorial/review duties. The COVID-19 pandemic increased the level of productivity of male and female academics in Africa in terms of hours/weeks spent on publications, patents, conference attendance/presentations (including virtually), grant applications, databases, acquiring tacit knowledge, consulting activities, and editorial/review duties. This may be due to reductions in the workload of African academics necessitated by the compulsory vacation created by the COVID-19 pandemic.

Table 2 about here: Level of productivity by gender of before and during COVID-19 pandemic in hours/week

There is a significant difference between the hours spent per week on publications (t = -2.320 at 5%); on patents (t = -2.165 at 5%) and on consulting activities (t = -1.782 at 10%) by female and male academics in Africa before COVID-19 pandemic. Specifically, male academics in Africa spent on average 6.30hrs/wk more than female academics in Africa on publications before COVID-19 pandemic. Also, male academics in Africa on average spent 7.03hrs/wk more than female academics in Africa in patents before COVID-19 pandemic. In the same way, male academics in Africa averagely spent 6.11hrs/wk more than female academics in Africa on consulting activities before COVID-19 pandemic. This implies that male academics spent more time in publications, patents, and consulting activities than their female counterparts before COVID-19 pandemic. Although male academics in Africa spent more hours per week on conference attendance/presentations (including virtually), grant application, databases, tacit knowledge and editorial/review duties than their female counterparts, however, the hours per week spent on these academic activities were not statistically significant. Therefore, no significant difference existed in the time spent on conference attendance/presentations (including virtually), grant applications, databases, tacit knowledge and editorial/review duties between female and male academics in Africa before COVID-19 pandemic.

Comparatively, during the COVID-19 pandemic, the result in Table 2 shows that there is a significant difference between the hours spent per week on patents (t = -2.920 at 1%) and editorial/review duties (t = -2.069 at 5%) by female and male academics in Africa during COVID-19 pandemic. Male academics in Africa averagely spent 11.98hrs/wk more on patents than their female counterparts during the pandemic. In the same way, male academics in Africa averagely spent 7.64hrs/wk more than their female counterparts in editorial/review duties. Although male academics in Africa spent more hours/week on conference attendance/presentations (including virtually), grant application, tacit knowledge and consulting activities than their female counterparts, however, the hours per week spent on these academic activities were not statistically significant. Likewise, female academics in Africa spent more hours/week on databases than their male counterparts; however, it was not statistically significant. Therefore, no significant difference existed in the hours/week spent on conference attendance/presentations (including virtually), grant applications, databases, tacit knowledge and consulting activities between female and male academics in Africa during COVID-19 pandemic.

4.3. Impact of COVID-19 on research productivity

Productivity was assessed using eight items namely publications, patents, conference attendance, grant applications, databases, tacit knowledge, consultancy, and review duties (SM 1). In the results, the majority of the respondents were uncertain regarding the impact of COVID-19 on

these productivity aspects. This evidence is demonstrated by a mean index of productivity of about 2.92 representing individuals who responded that the impact was neither positive nor negative. Nevertheless, the highest percentage of extremely negative impacts were in patents (6.1%), grant applications (5.5%), conference attendance (9.6%) and consultancy activities (4.8%).

4.4 Accessibility of Research Support Resources During COVID-19

Accessibility of research support items during COVID-19 was assessed in the study. Specifically, we looked at access to internet, books and resources, colleagues, field equipment, laboratory, childcare, office space, electricity supply, and office equipments. The majority of the respondents were uncertain regarding the accessibility of the mentioned research items during the COVID-19 pandemic (SM 2). This is demonstrated by a mean index of accessibility of about 3.09 representing individuals who responded that the accessibility of research support items was about the same. Nevertheless, the highest percentage of much worse accessibility were in-field equipment (15.1%), laboratories (17.0%), colleagues (8.4%), office space (10.9%) and office equipments, laptops and desktops (6.8%).

4.5. Accessibility effect of research support activities on research productivity

The accessibility effect of research support resources (namely internet access, books and library resources, colleagues, field equipment, laboratories, childcare, office space, electricity supply, and office equipments) on research productivity was also assessed. In the results (SM 3), most of the respondents were uncertain regarding how accessing the research support items stated above affected research productivity during COVID-19 era. This evidence is demonstrated by a mean index of accessibility effect of about 3.13 representing individuals who responded that the effect was neutral. Nevertheless, the highest percentage of major effects were in laboratories (20.6%), field equipment (19.0%), colleagues (12.5%), office space (14.8%) and electricity supply (13.5%).

4.6. Importance of research support items on research productivity during COVID-19

The level of importance of research support items (namely internet access, books and library resources, colleagues, field equipments, laboratories, childcare, office space, electricity supply and office equipments) during COVID-19 was also assessed. In the results (SM 4), the research support item with the lowest mean had the highest level of importance which is internet access. The overall mean level of importance on research productivity is about 4.89. Nevertheless, the most important research item that was mentioned to support research productivity during COVID-19 was internet access (2.0), followed by books and library resources (4.1), electricity supply (4.3), colleagues (4.8), and the least being childcare (6.2) and office space (6.3).

4.7 Average hours spent on research activities per week before and during COVID-19

The average amount of hours spent on research activities per week before and during COVID-19 was assessed using eight items namely publications, patents, conference attendance, grant applications, databases, tacit knowledge, consultancy activities, and review duties. In the results, the majority of the respondents, on average, used 13 hours and 13.4 hours on publication before and during COVID-19, respectively (SM 5). Also, on grant applications, the majority spent 6.8 hours and 6.7 hours per week before and during COVID-19, respectively. The average hours that were used on databases remained the same, before and during COVID-19 at 7.3 hours per week.

Before COVID-19, publications on average had the highest time (13 hours) per week, followed by tacit knowledge (10 hours), consultancy services (9.4 hours) and the least was patents with 3.8 hours per week. During COVID-19, again time for publication slightly increased by 0.4hrs/wk, followed by conference attendance which increased by 1.4hrs/wk, tacit knowledge with 8.7hrs/wk and patents again took less time with 3.7hrs/wk. Generally, there was a reduction in patents (0.1hrs/wk), grant applications (0.1hrs/wk), tacit knowledge (1.3hrs/wk), consultancy activities (1.8hrs/wk) and review duties at 0.6hrs/wk. This evidence is demonstrated by an average time index before COVID-19 of about 8.40 hours and an average time index during COVID-19 of about 8.14 hours showing an overall effect of 26% on the research activities during COVID-19.

4.8. Differentials in research productivity (Differentials in research productivity with correlations)

Table 3 shows the results of the Pearson's correlation employed to examine the relationship between continuous independent variables and research productivity. The most significant ones were accessibility to research resources, accessibility effect, average hours before and during Covid-19, number of dependents, number in household and years of experience.

Table 3 about here: Table 3: Correlation between continuous independent variables and research productivity

4.8.1 Accessibility to Research Resources

There is a significant, moderate, and positive correlation between accessibility and research productivity ($r = 0.33$, $p < 0.01$). In testing the relationship between variables, 0.33 is moderate, within the range of 0.30 to 0.60 is considered moderate and less than 0.30 would be weak. The relationship between the variables is stated as 0.33, which further reinforces the relatively moderate relationship between accessibility to research resources and research productivity. This correlation indicates that the higher the accessibility to items listed in Table 3 during Covid-19, the higher the research productivity.

4.8.2 Accessibility effect

There is a significant, weak, and positive correlation between accessibility effect and research productivity ($r = 0.18$, $p < 0.05$). The relationship between the variables is stated as 0.18, which explains the relatively weak relationship between the accessibility effect and research productivity. This correlation indicates that the more positive the accessibility effect is towards the accessibility items listed in Table 3 during Covid-19, the higher the research productivity.

4.8.3 Average hours before and during Covid-19

There is a significant, weak, and negative correlation between average hours before Covid-19 and research productivity ($r = -0.18$, $p < 0.01$). The relationship between the variables is stated as -0.18, which further affirms the very weak relationship between the average hours before Covid-19 and research productivity. This correlation suggests that the higher the average hours before Covid-19 towards the research activities listed in Table 3, the lower the research productivity. Plus, academics tend to have a flexible schedule, and many do significant amounts of work at home.

There is a significant, moderate, and negative correlation between average hours during Covid-19 and research productivity ($r = -0.36$, $p < 0.01$). The relationship between the variables stated as -0.36, further reinforces the moderate relationship between the average hours during Covid-19 and research productivity.

4.8.4 Number of dependents, number in household and years of experience

There is a significant, weak and negative correlation between numbers of dependents and research productivity ($r = -0.09$, $p < 0.1$). The relationship between the variables is stated as -0.09, which explains the relatively very weak relationship between the numbers of dependents and research productivity. This will especially be the case where a majority of the dependents are in a category that needs attention. There is no significant correlation between the level of importance on research productivity, number in household, years of experience, and research productivity ($r = 0.03$, $r = -0.06$, and $r = -0.01$ respectively, $p > 0.1$, 0.01 and 0.05).

4.9 Differentials in research productivity with ANOVA

Table 4 shows results obtained when we statistically tested the relationship between research productivity and key demographic and performance indicators.

Table 4 about here: Difference in mean categories and research productivity

When the hypothesis stating the relationship between the research productivity and kind organization of the respondent was tested using ANOVA, it was found that [$F(1, 309)=4.53$, $p=0.03$]. The null hypothesis was rejected at 5% level of significance. The results also indicate that contract type, work out of office due to Covid-19, and the effect of Covid-19 on workload, and on mental health, significantly affected ($p < 0.05$) research productivity. Therefore, it could be concluded that there were significant differences among the mean scores of the kind of organization, contract type, work out of office due to Covid-19, the effect of Covid-19 on workload, and on mental health, on research productivity during Covid-19.

When the hypothesis comparing the relationship between research productivity and gender of the respondent was tested, it was found that there is a non-significant difference between productivity and gender [$F(1, 309)=1.17$, $p>0.05$]. The null hypothesis was thus accepted at the 5% level of significance. It was also found that the calculated values of *p* for the age group (year), marital status, educational level, current research position, organization closed due to Covid-19, the effect of Covid-19 on income and mental health support by the employer for Covid-19 was greater than $\alpha = 0.05$.

4.10. Predictors of research productivity during COVID-19

A multiple regression analysis was performed in this section to identify the predictor and its contribution towards research productivity during Covid-19. It aims to determine the prediction of a single dependent variable from a group of independent variables. The result of the multiple regression is presented in Table 5. The multiple regression equation is as follows:

RP = Constant + 0.31 AS + 0.09 WL + 0.01 BC – 0.01 DC *** value of the constant should be provided

Where,
RP = Research productivity
AS = Accessibility to research resources
WL = COVID-19 on workload
BC = Before COVID-19
DC = During COVID-19

Four significant predictors (i.e., accessibility to research resources, COVID-19 on workload, before COVID-19 and during COVID-19) out of eleven independent variables were found to be positively related to research productivity in the regression equation, as shown in Table 5. Accessibility has the highest regression coefficient at (0.31), followed by Covid-19 on workload, (0.09), before Covid-19, (0.01), and during Covid-19, (-0.01). Effects from other predictors are insignificant in this set of combinations and are therefore not included in the multiple regression equation.

Table 5 about here: Multiple regression analysis with the significant variables

5. Discussion and Conclusion

The COVID-19 pandemic brought with it widespread changes such as working from home to research working practices which are likely to be persistent even after the pandemic ends. This paper used data collected through a survey of 311 researchers working in Africa to examine how COVID-19 has affected the productivity of researchers working on the continent. Broadly speaking, participants were asked about changes in their productivity before and during (end of the first lockdown in their respective countries) the pandemic. This study adds to the growing literature on research productivity in a time dominated by working from home, an important emerging topic in research policy.

We found that researchers are spending about 22 hours per week extra working than before the Covid pandemic hit. This could be time saved from commuting, knowing that traffic congestion can hobble many African cities with long commuting times (Harriet, Poku, & Emmanuel, 2013; Lall, Henderson, & Venables, 2017). This result confirms suggestions that on average working from home during COVID 19 crisis resulted in people spending more time working than they normally would pre COVID 19 (Office for National Statistics, 2021). This underscores the fact that employees who are not in the office are not necessarily absent, distant, or not working. Research institutions in Africa should be more open to providing opportunities for staff and their managers to work from home when necessary or needed. Although overall time spent working during COVID-19 has increased, the general perception of respondents is that this has not translated into an enhanced level of productivity. This indicates that researchers will require support on how to best optimize the benefit from the increased time commitment while working from home. This could include simple programs such as a short break in regularly-spaced intervals that keep the researcher from being mentally stagnant (Ali & Kunugi, 2020; Diamond & Byrd, 2020). To do this, research institutions in Africa will need to do more in providing employees with physical and mental health support.

Our results underscore the gendered dimension in research productivity during the COVID-19 pandemic (Arntz et al., 2020; Cui et al., 2020; King & Frederickson, 2021; Myers et al., 2020).

This brings to the forefront the long-existing issue of gender inequality in research (Ahl, 2004; Jappelli, Nappi, & Torrini, 2017). The result that, before COVID 19, male researchers were able to spend more time on publications, patents and consulting activity than their female counterparts shows that gender inequalities remain common in Africa's research community (Carr-Hill, 2020; Mama, 2003). Since this sector traditionally favors indicators such as publications in the promotion process suggests that COVID-19 might further disenfranchise female academics. This finding is instructive for managers of research institutions in Africa, working to enhance gender equality in the sector. Although working from home during the COVID 19 provided female employees some flexibility and opportunity to balance work and family, they are worse placed to be productive in a key indicator for career progression: publications. There is the urgent need to support female researchers to increase the hours they are able to spend working on publications, patents and consultancy.

We found that the COVID 19 has affected face-to-face conference attendance as respondents reported lower participation in such conferences than they would normally do. This represents a departure from what one would have expected because of the reported popularity and appreciation of virtual science conferences during the COVID-19 pandemic (Remmel, 2021). This could be due to many factors including that most of the regional conferences for African researchers were cancelled (Ataguba, 2020) and access to virtual conferences would have been curtailed due to the poor infrastructure (electricity, internet) needed to fully participate in virtual conferences (Bottanelli et al., 2020). Going forward, organisers of international scientific conferences need to be aware that every region does not have the same infrastructure and opportunities to join online events. Failure to do so may further entrench inequality in the global scientific research space. This highlights the need for organisers of international conferences in the west to consider how to best enhance the participation of African academics in their virtual conferences.

The finding that suggests a correlation between accessibility to resources during Covid-19 and research productivity underscores the need for research institutions in Africa to support staff in gaining access to resources such as a good internet. Our findings also show that the lack of access to "on-site" research activities —in laboratories or the field were major factors that respondents believe have affected their productivity. In essence, there is a need to design practices that will facilitate access or develop novel procedures for carrying out those activities in a socially distant way. This will require research institutions in Africa to invest in infrastructure, especially on ICT considering the present scenario.

Similar to some of the emerging studies on the impact of COVID-19 on research productivity, we also found that the kind of organization a researcher is working in, and contract type (full-time or part-time) are factors that affect research productivity. This can help target organisations and categories of researchers to support. Furthermore, the four significant predictors that are positively related to the research productivity provide insight to policymakers as to aspects to focus on.

While it might be too early to expound on the full impact of COVID-19 on research productivity, our study does provide insight into issues African research institutions should respond to while the pandemic last and if a similar crisis occurs in the future. The evidence provided in this paper

is relevant for policy in several ways. Most importantly it contributes to our understanding of the factors that affect research productivity during the pandemic. This in turn helps inform policymakers of the likely areas to focus their interventions on.

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Table 1: Summary statistics of the socioeconomic characteristics of the study population

Variable	Frequency (n=311)*	Percentage (%)
Gender		
Female	170	55
Male	141	45
Age group(year)		
18-24	23	7.4
25-34	84	27.0
35-44	96	30.9
45-54	88	28.3
55-64	20	6.43
Number in a household		
1-5	196	63.0
6-10	102	32.8
11-15	9	2.9
16-20	4	1.3
Number of dependents		
0-4	232	74.6
5-10	73	23.5
11-15	5	1.6
16-20	1	0.3
Marital Status		
Married or domestic partnership	199	64.0
Single, never married	100	32.2
Divorced or separated	12	3.9
Education level		
Bachelors	59	19.0
Masters	131	42.1
Doctorate	112	36.0
Others	9	2.9
Kind of organization (n=273)		
Academia/Research	208	76.2
Government/Public services	31	11.4
IT Consultancy/Development	15	5.5
Small and medium enterprise	19	7.0
Current research position (n=266)		
University lecturer	98	36.8
PhD student	79	29.7
Research associate	46	17.3
Master student	22	8.3
Postdoctoral research	21	7.9
Years of experience		
0-4 years	108	34.7
5-10 years	91	29.3
11-15 years	53	17.0
16-20 years	22	7.1
21-25 years	19	6.1
26 and Above	18	5.8
Contract Type		
Permanent and full time	175	56.3
Permanent and part-time	16	5.1
Temporary and full time	54	17.4
Temporary and part time	24	7.7
Others	42	13.5
Organization closed due to Covid-19		
No	81	26.0
Yes	230	74.0
Work out of office due to Covid-19		
No	85	27.3

Yes	226	72.7
Effect of Covid-19 on income		
Increased income	12	3.9
Neither reduced nor increased income	156	50.2
Reduced income	143	46.0
Effect of Covid-19 on workload		
Increased workload	70	22.5
No change	104	33.4
Reduced workload	137	44.1
Effect of Covid-19 on mental health		
Much better	28	9.0
Somewhat better	36	11.6
About the same	156	50.1
Somewhat worse	75	24.1
Much worse	16	5.1
Mental health support by employer for Covid-19		
No	258	83.0
Yes	53	17.0

***When n is not 311, it is due to missing values.**

Table 2: Level of productivity by gender of before and during COVID-19 pandemic in hours/week

Level of Productivity	Female (A)	Male (B)	Combined (C)	Difference (A-B)	T-test (A and B)
Before COVID-19 Pandemic					
Publications	18.26	24.56	21.41	-6.30	-2.320**
Patents	6.74	13.77	10.25	-7.03	-2.165**
Conference attendance/ presentations (including virtually)	15.43	15.60	15.51	-0.17	-0.064
Grant applications	14.29	14.70	14.50	-0.41	-0.143
Databases	17.68	18.02	17.85	-0.34	-0.106
Tacit knowledge	18.21	22.56	20.39	-4.36	-1.283
Consulting activities	16.68	22.79	19.74	-6.11	-1.782*
Editorial/Review duties	15.70	17.93	16.81	-2.24	-0.723
During COVID-19 Pandemic					
Publications	23.05	25.48	24.27	-2.43	-0.484
Patents	7.30	19.28	13.29	-11.98	-2.920***
Conference attendance/ presentations (including virtually)	20.66	21.73	21.19	-1.07	-0.302
Grant applications	15.64	18.39	17.01	-2.74	-0.883
Databases	22.15	18.46	20.30	3.69	0.849
Tacit knowledge	21.32	25.25	23.28	-3.93	-1.007
Consulting activities	17.91	22.24	20.07	-4.33	-1.093
Editorial/Review duties	15.95	23.59	19.77	-7.64	-2.069**

Source: Field survey data, 2020

T test values were generated using the independent sample t-test approach.

**** represents 1%, ** represents 5%, *represents 10% levels of significance.*

Table 3: Correlation between continuous independent variables and research productivity

Themes	Dependent Variable
	Research Productivity
2: Accessibility to research resources	0.33
	0.00***
3: Accessibility effect	0.18
	0.00**
4: level of importance on research productivity	0.003
	0.95
5: Average hours before Covid-19	-0.18
	0.001***
6: Average hours during Covid-19	-0.36
	0.00***
7: Number in households	-0.06
	0.305
8: Number of dependents	-0.09
	0.1*
9: Years of experience	-0.01
	0.87

*Correlation is significant at *$p < 0.1$, **$p < 0.05$, and ***$p < 0.01$

Table 4: Difference in mean categories and research productivity

Variable	Source	df	SS	MS	F	p-values
Gender	Between groups	1	0.36	0.36	1.17	0.28
	Within groups	309	95.7	0.31		
Age group(year)	Between groups	4	1.26	0.32	1.02	0.40
	Within groups	306	94.8	0.31		
Marital status	Between groups	1	0.77	0.77	2.49	0.12
	Within groups	309	95.3	0.31		
Education level	Between groups	1	0.74	0.74	2.39	0.12
	Within groups	309	95.4	0.31		
Kind of organisation	Between groups	1	1.57	1.57	4.53	**0.03***
	Within groups	271	94.3	0.35		
Current research position	Between groups	1	0.22	0.22	0.60	0.44
	Within groups	264	95.5	0.36		
Contract type	Between groups	1	1.31	1.306	4.26	**0.04***
	Within groups	309	94.8	0.31		
Organization closed due to Covid-19	Between groups	1	0.70	0.70	2.26	0.13
	Within groups	309	95.4	0.31		
Work out of office due to Covid-19	Between groups	1	1.83	1.83	6.01	**0.01***
	Within groups	309	94.3	0.31		
Effect of Covid-19 on income	Between groups	1	0.09	0.09	0.29	0.59
	Within groups	309	96.0	0.31		
Effect of Covid-19 on workload	Between groups	1	1.55	1.55	5.07	**0.03***
	Within groups	309	94.6	0.31		
Effect of Covid-19 on mental health	Between groups	1	5.01	5.01	17	**0.00*****
	Within groups	309	91.1	0.30		
Mental health support by employer for Covid-19	With groups	1	0.93	0.93	3.02	**0.08***
	Between groups	309	95.2	0.31		

Table 5: Multiple regression analysis with the significant variables

Variables	Coefficient	CI	p-values
Accessibility	0.31	0.17-0.46	0.000***
Accessibility effect	0.01	-0.11-0.12	0.900
Before Covid-19	0.01	0.01-0.02	0.001***
During Covid-19	-0.02	-0.03- -0.02	0.000***
Number of dependents	-0.01	-0.03-0.02	0.540
Kind of organization	0.06	-0.02-0.13	0.138
Type of contract	0.04	-0.02-0.10	0.206
Work out of office due to Covid-19	-0.10	-0.27-0.06	0.212
Covid-19 on workload	0.09	0.01-0.16	0.03**
Covid-19 on mental health	0.06	-0.01-0.12	0.08
Support on mental health due to Covid-19	-0.09	-0.25-0.07	0.300