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## COVID-19 impact on the Chinese top academic libraries: Libraries' response to space, collection and services

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### ABSTRACT

In 2020, the COVID-19 pandemic was a major public health emergency on a global scale. The literature regarding the pandemic and its impact on academic libraries is still rising. This article examines the two-year process of developing a flexible service scenario and the broader picture by analyzing data on Chinese top university libraries' programmes and outreach initiatives prior to, during, and the normal COVID-19 pandemic (Sept. 2019–Sept. 2021). COVID-19 is found to have a significant impact on the physical space, collection development, and service of the library, demonstrating the characteristics of space access restricted by security measures, collection digitization, and online service. This research also examines the previous year's initiatives and programmes and discusses the next phase of “new normal” procedures. Hopefully, this study will give insight on how Chinese libraries responded to the recent pandemic, informing libraries' outreach and efforts to be better prepared to take imperative, swift, and decisive action in the post-COVID-19 era and beyond.

### Introduction

In China, university libraries have made great progress in printed and digital materials development, remote access to digital resources, and physical space service in the past two decades (Wu & Wang, 2021). The outbreak of COVID-19 poses challenges to in-person library services and remote online programmes. The current COVID-19 pandemic environment for many academic libraries is one of uncertainty and focus on modifying, extending, and adding services as well as protecting the safety of staff and patrons. Thus, there is a growing literature on libraries' responses to cope with the situation, especially the beginning phase of the COVID-19 (see, for example, American Library Association, 2020; Heady et al., 2021; IFLA, 2020; Rafiq et al., 2021). However, a comprehensive overview of the range of typical services libraries are developing prior to the COVID-19, as well as during and the normalized three phases are still inadequate. Additionally, there is a dearth of literature on how libraries have responded to these specific transformations, including physical space service, collection development, and various service and programme offerings, and whether this has resulted in a significant shift in the direction of services. Facing the worldwide COVID-19 pandemic, academic libraries in different countries have been exploring how to cope with the situation (e.g., Brine &

Knight, 2021; Chisita & Chizoma, 2021; Farne et al., 2021). However, there has not yet been a systematic recording of the service responses and changes made in China. It started implementing the normalization of pandemic prevention and control measures since September 2020 (hereafter the normal or new normal). This study is intended to fill this research gap, and track and record the responses and changes made by Chinese top university libraries, to learn from the experience, plan for future disasters, make more informed decisions about continuous service improvement in librarianship, and contribute to the body of knowledge relating to libraries' response to the crisis events. Therefore, this study traced, investigated, and presented the initiatives and programmes in all three stages among Chinese top university libraries to make informed decisions about ongoing service improvements and plan for future disasters. More specifically, it seeks to answer the following research questions:

RQ1. What are the space redesign, collection development, services, and methods used to serve the community by Chinese top university librarians prior to the pandemic? What effect does the COVID-19 pandemic have on all of these?

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RQ2. How do academic libraries in China respond to the COVID-19 pandemic in terms of physical space, collection, development, and services?

## Literature review

Before the COVID-19, researchers had conducted many studies to understand the learning commons and space service, printed collection development and circulation services, and online information service delivery. With the outbreak of COVID-19 pandemic, in the last two years, there has been an increasing body of research on academic libraries' responses to the COVID-19 pandemic. The literature shows that the experiences of academic libraries centered on the transition from physical to online delivery of information services, ensuring uninterrupted library services (e.g., [Hinchliffe & Wolff-Eisenberg, 2020a](#); [Hinchliffe & Wolff-Eisenberg, 2020b](#); [Wijayasundara, 2021](#)). During the COVID-19 pandemic situation, academic libraries have taken actions to provide resources, services, and programmes in innovative ways, such as moving their services online and providing remote access to digital resources, delivering virtual reference services (i.e., automatic pop-up window, asking a librarian through website and social media) ([Abubakar, 2021](#)), offering zero-contact checkout service ([Guo et al., 2021](#)), supporting mental health and well-being ([Bladek, 2021](#); [Cox & Brewster, 2020](#)), and against misinformation/fake news ([Bangani, 2021](#)). In the meantime, libraries closely follow public health protocols and adhere to university safety guidance to both safeguard their user's safety and continue to serve them at the same time ([Devan & Tripathi, 2021](#); [Fasae, Adekoya, & Adegbilero-Iwari, 2021](#)).

### *Learning commons and space service*

Over the last decade, there were significant developments and discussions about library space transformation related to the construction of concepts such as “leaning commons” ([Chan & Wong, 2013](#); [Oliveira, 2018](#); [Thomas et al., 2015](#)), “library as place” ([Aabø & Audunson, 2012](#); [Garnar & Tonyan, 2021](#)), “leaning and social space” ([Bryant et al., 2009](#); [May & Swabey, 2015](#); [Ojennus & Watts, 2017](#)), quiet areas for individual study and collaborative space ([Cha & Kim, 2020](#); [McCaffrey & Breen, 2016](#)) etc. Academic libraries as physical spaces play in the academic community support self-directed and collaborative learning, community interaction and engagement, performing activities, and the creation of new knowledge ([May & Swabey, 2015](#); [Oliveira, 2018](#); [Vassilakaki & Moniarou-Papaconstantinou, 2021](#)), and they also offer printed and electronic access to their collection as well as various services, such as in-person reference and face-to-face instruction interaction. There is a trend in the literature to see the library as a learning and social space where collaborative learning and community interaction and engagement can take place. As a result of COVID-19, most library buildings were temporarily closed in the initial months of the pandemic. To mitigate the spread of the virus, libraries transitioned from providing on-site and in-person services to virtually through digital service delivery. Ranging from complete closure to reopening, there is a wide spectrum of practices, such as reconfiguring or removing furniture and limiting access to group study rooms for social distancing requirement ([Farne et al., 2021](#); [Scoulas et al., 2021](#)), partially open and social distancing policies ([Heady et al., 2021](#)), or reduce the opening hours of the library ([Fasae, Adekoya, & Adegbilero-Iwari, 2021](#)). Generally speaking, it presents a mixed-mode of completely closed, semi-closed or limited access ([Rafiq et al., 2021](#)). This study will address the impact of the pandemic on users' experiences with Chinese libraries' buildings and spaces and the adjustment mode of the library's own physical space, entrance and internal demand.

### *Printed collection development and circulation services*

Library resources and service provision are the most important and

necessary components, and they are typically listed as the most visible columns on library websites. Collection development continues to be an important activity for all types of libraries and an important skill for new and trainee librarians ([Johnson, 2018](#)). With the emergence of new technologies and approaches to managing and developing collections, a variety of collection initiatives have been developed in recent years, especially for libraries to work more collaboratively with patrons, vendors, and other partnerships, including the approval plan, librarian selection, patron-driven acquisition (PDA), demand-driven acquisitions (DDA) programmes, purchase suggestions, inter-library loan, and documentation delivery. These initiatives are examples of how the concept of “collections as a service” can be realized ([Linden et al., 2018](#)). In China, PDA or DDA patron involvement acquisition programmes are becoming increasingly prevalent in college and university libraries, namely “borrowing printed materials directly from participating bookstores online or sites and returning them to the library”, which is an updated PDA model whereby patrons borrow rather than purchase from participating bookstores, such as local Xinhua bookstores and Jingdong vendors (similar to Amazon), based on stringent criteria (e.g., items suitable for collection or books could not cost more than a certain amount). The earliest adopter of this programme is the Inner Mongolia Library in China, where the four 2016 ALA Presidential Citation award winners were recognized for designing and implementing highly visible, innovative services that greatly improve existing library services for users. The innovative “You (readers) read, I (library) purchase; You are a decision-maker for your library” service philosophy promotes national reading and higher circulation rates. It has proven to be an innovative solution to the continued decline in printed circulation and user complaints about the unavailability of newly published books or high-demand items ([ALA Presidential Citation for Innovative International Library Projects, 2016](#)). The programme has received widespread acceptance as a viable collection development solution ([Duan & Wang, 2018](#)). Correspondingly, it was noted that the circulation service is an important, traditional library service ([Kang et al., 2019](#)). However, no access to the physical collection nor the physical library at the beginning of the pandemic to the zero-contact services (i.e., ‘Click & Collect’ service, book delivery services) to facilitate access to as much of the physical collections as possible were the notable modes during the initial COVID-19 ([Guo et al., 2021](#); [Oche, 2021](#); [Zhou, 2021](#)). COLINET librarians surveyed admit that the COVID-19 pandemic has created a huge demand for electronic resources, with libraries even stopping purchasing printed resource ([Pryce et al., 2021](#)). For example, [Merchant and Ahmed \(2021\)](#) conducted a survey of academic libraries' responses to the COVID-19 pandemic in Pakistan and found that circulation service was reported to be the most affected, either suspending all the circulation services (71.7% libraries) or providing the circulation services with limited hours and strict protocols (11.7%) or through courier (6.7%). Whether it is borrowing from the library or mailing, the acquisition of printed materials is greatly affected, limited access to print collection, after the resources are returned, the resources need to be isolated to reduce direct contact with resources that may be infected ([Harris, 2021](#)). This study will address the impact of the pandemic on printed materials acquisition and loan services provided by Chinese libraries.

### *Online information service delivery*

The digital era provides numerous opportunities for developing innovative services, giving access to a wide range of information resources, and promoting online service delivery, such as the digital library and digital space ([Chisita & Chizoma, 2021](#); [Vassilakaki & Moniarou-Papaconstantinou, 2021](#)), e-resources on-and off-campus access, virtual reference services ([Abubakar, 2021](#); [Mu et al., 2011](#)), information literacy instructions ([Guo & Huang, 2021](#); [Guo & Zhu, 2019](#); [Huang et al., 2016](#)) and other online activities (e.g., reading promotion) through a website portal, social media, and e-learning and conference platforms, etc. The transition to digital services had been occurring.

However, the COVID-19 pandemic reinforced and accelerated the process toward large-scale digital initiatives supporting the teaching, learning, and research objectives of the entire user community (Pryce et al., 2021; Temiz & Salelkar, 2020; Thorpe & Howlett, 2021). The digital library services of almost all university libraries are booming, ensuring that university libraries continue to support learning, research and teaching (Chisita & Chizoma, 2021). Most libraries suspended face-to-face consultations and offered online consultations (Heady et al., 2021), facilitating e-learning courses material (Jana & Rout, 2021), and online study/research support sessions (Thorpe & Howlett, 2021). This study will explore how the pandemic lockdown period impacted users' access to online services and digital collections. There are also a number of articles that intend to carry out a survey to identify their libraries' practices in response to COVID-19. In China, several somewhat similar studies were undertaken during COVID-19, Wang et al. (2020) quickly launched a survey on March 11th to gather detailed information about how Chinese academic libraries were responding to the crisis. Similarly, Guo et al. (2021) conducted a survey from February 12 to April 5, 2020, to identify the measures employed in the provision of patron services in 137 Chinese academic libraries responding to the COVID-19 pandemic. It's worth noting that the aforementioned surveys were conducted in the early months of the pandemic and reported on initial experiences. Most recent studies (see Leung, Chiu, Ho, & Luk, 2022; Otike et al., 2021) also reported user perceptions and roles of libraries and librarians in the post-epidemic era. However, the status of their patron services is in the process of dynamic changes, it is difficult to cover comprehensively, none have been carried out ranging from prior, during, and the normal COVID-19 pandemic.

## Methodology

### Research sample

This article studied 42 academic libraries from the World First Class University development initiative designed by the People's Republic of China government in September 2017 (Ministry of Education of the People's Republic of China, 2017). Most of the 42 double first-class universities are considered among the top 500 universities in the world. As such, this group of universities and libraries is more equipped with IT infrastructure and technologies and financial support, and their librarians can adopt various library tools and techniques and develop innovative services to engage their communities virtually. The results of this study can serve as a model for other libraries undergoing a transition and uncertainty.

### Research method

In this research, we used content analysis approach where data is collected from library websites, WeChat official accounts, and direct communication with the libraries concerning library operations (i.e., spaces, resources, and services) per institution.

### Timeline

Data collection is focused on three phases in the Sept. 2019–Sept. 2021 to capture the wide range of innovative practices and shifts: 1) prior to the COVID-19 pandemic (Fall 2019 semester–January 23, 2020 winter break, the outbreak of COVID-19 in China), 2) during the initial pandemic (Spring semester in 2020, from February 2020 to August 2020), and 3) the normal COVID-19 (Fall 2020 semester, September 2020, reopening–the start of Fall 2021 semester, September 2021).

### Coverage

The transition of library resources, services, programming, and spaces, and the characteristics and impacts of each service among these university libraries were traced and documented for the period 2019 to 2021 continuously.

### Data collection

The authors comprehensively browsed and recorded the service responses and changes made through visiting the university and their respective library websites, WeChat official accounts, literature analysis, and corresponding with the studied libraries together to ensure the accuracy of the data. More details about data collection and analysis are including: 1) Students are given final assignments by the first author's course in every Fall semester pre-pandemic period to collect the latest practices on resources, services, programming, and spaces through library websites, WeChat official accounts, published literature and Ask-a-librarian reference. 2) The third and fourth authors together comprehensively browsed the sections related to space, services and collection and COVID-19, then each university's website, library websites and WeChat official accounts are visited. The qualitative data is collected from press releases and announcements as well as communications with the libraries via online references, telephone or email to ensure the accuracy of the data. The transition of library resources, services, programming, and spaces, and the characteristics and impacts were collected and imported into initially to word and then to MS-Excel spreadsheets, which obtained a total of 1680 records for 42 academic libraries. 3) Then the first two researchers independently read and analyzed the data. Each researcher created codes, categorized and summarized them, and then discussed their codes and findings via WeChat. 4) All the authors discussed continuously, some codes are removed, and some are combined or revised, and finally, an excel sheet is created. As a result, three themes, four subsections and six types of services are summarized.

## Findings

The findings are divided into three categories: physical space and precautionary measures, collection development, and services such as printed materials circulation, electronic resource access, reference, instruction, and training sessions, as well as document delivery and inter-library loan. Each section will include noteworthy findings on library operations prior to and following the COVID-19 pandemic, as well as corresponding changes.

### Physical space and precautionary measures

Before the pandemic, the majority of academic libraries introduced diverse areas (i.e., group study rooms, large common study areas, learning commons, relaxing spaces or nap stations, coffee shops and amenities for food and drink, and technology free areas where users can put aside their devices and disconnect from the network), and extended opening hours for users' engaging in a wide variety of activities, for example, completing academic work on their own or collaborative social learning, to engage in workshops and group activities, using print materials and facilities, and face-to-face references.

All libraries under study were closed to a full extent from 23rd January 2020 to April or May 2020 due to the COVID-19 pandemic outbreak. The library staff moved the day-to-day in-person work to fully virtual and remote for the duration of the peak periods. As summer 2020 showed a marked decrease in COVID-19 cases in China, from April or May 2020, there were partial openings of the library, a modified opening in fall 2020, and a full open status beginning in November 2020, under the constraints of COVID-19 practices. Almost all libraries had COVID-19 spikes, closures, and reopening at various times throughout 2020. As they begin reopening, they closely follow public health developments and adhere to university and local safety guidelines. For example, access by appointment only, mask must be worn, social distancing requirement, ban on food and inflammable and explosive materials, cleaning, & infection safety measures, added some remote access facilities, etc. (See more details in [The summary changes of facilities and procedures](#)). Among them, 100% of libraries had both mask and social distancing policies in place and strict reservation policies,  $\leq 37.2$  °C and green

health code or itinerary card<sup>1</sup> for permission as well as more rigorous cleaning were also mentioned in the announcements, mainly through the library portal and WeChat official account, while 38.5% of libraries completely closed air conditioning and elevators during the crisis and any surge in positive cases in the communities in the new normal era. In addition, because of the COVID-19 epidemic, most libraries also restricted their opening hours. Multiple restrictions and measures have brought many inconveniences to users, and libraries have also increased remote access facilities to provide users with abundant online services and resources. Libraries also have some special arrangements for special periods, such as delivery service to the campus buildings, extend loan period of materials etc., Fig. 1 shows an image of the timeline from library building closure to partial opening, a modified opening and a full open status, and to a modified partial opening due to epidemic strikes again, the timeline documented what Xiamen University Library, in Fujian Province did and when, and as a snapshot of what happened (Xiamen University Library, 2021).

### Collection development

#### Printed materials

Before the pandemic, approximately 98% of libraries combined the traditional collection development model for books and well-established approaches such as PDA, accounting for the majority of purchases, including five order or selection approaches: print books acquired via librarians' orders, book vendors' selections for the approval plan, suggesting a purchase via patron, donation (i.e., targeted donor bequests), and PDA. In China, acquisition librarians visit several selected book vendors' warehouses or large-scale book fairs for on-site selections and orders twice a year, which is the essential acquisition mode pre-COVID-19. During the initial months of the pandemic, due to the stay-at-home mandate and halt of express delivery services, all libraries completely paused the purchase of physical items immediately, and many choose to supply more digital resources. Since May 2020, 69% of libraries (29/42) offered cloud-based purchase of physical books, integrating user selections online, and the majority of libraries allowed patrons to borrow books directly from Xinhua bookstores or Jingdong vendors through mobile applications, and provide home delivery services. As of September 2021, print books acquired via users' and librarians' orders online are a priority approach, as it will provide enhanced online access to printed books to all users, and on-site selections and orders are also implemented in the context of the normalization of epidemic prevention and control.

#### E-resources

Most university libraries subscribe to a number of databases of e-books and e-journals and have created their own institutional repositories and special collection platforms, which include locally produced materials as well as open access resources and free trials. These collections were available via the library website before COVID-19. During the lockdown period, the majority of academic libraries focused their efforts on the maintenance and promotion of existing electronic resources, while they enriched their digital collections by organizing temporary databases and other electronic resource trials, particularly related to textbooks by subscribing to new databases or

scanning chapters of needed books or electronic reserve system implementations (see [Course materials](#)). In addition, many commercial digital content providers and vendors have eased license restrictions and made them freely available for a limited period. Librarians have compiled links to these free electronic materials and e-book databases and updated and released them frequently to the website and social media. Most libraries are procuring more and more electronic resources and expanding their digital offerings to include more open access resources and free trials, and the expansion of electronic textbooks (e-textbooks) for hybrid teaching methodology in the new normal era, as well as facilitating resource sharing and consortia subscriptions via libraries' consortium.

### Services offerings

#### Circulation

Before the pandemic, libraries provided open shelves, online catalogues, machines for item retrieval, and self-check-in/out items from physical collections on site. All institutes have temperately suspended the physical circulation of materials after the lockdown and announced that all overdue fines were waived, ignoring automated notices from the circulation system and extended the loan period until an undefined date. Over half (62%) of the sampled libraries offered contactless pickup options, such as delivery service to the campus buildings; home library services; pick-ups at the library main entrance; and other contactless services like physical scanning of book chapters or journal articles during the pandemic crisis since February 2020. Users of Chongqing University Library, for example, select books from catalogues and send their requests to the library via email or phone call or OPAC request; librarians prepare book packages and leave them in the library main entrance or designated preferred pick-up location on campus, users must wear a face covering and follow all instructions; in some cases, library use postal services to deliver items. When books are returned by on-site self-check machines, or dropbox, or couriers, they are kept untouched for 72 h and only afterward are they re-shelved ([Chongqing University Library, 2020](#)). Similarly, print materials housed in Peking University Library were able to be requested via an updated Book Delivery-to-Door Service Mini-App, access services staff wear hand gloves and masks, put the items into plastic bags and deliver them to the few users remaining in campus residences upon receiving a request Monday through Friday between 9:00–11:00 am and 2:00–4:00 pm since February 3, 2020, as a pilot service ([Peking University Library, 2020](#)).

Data found that in many instances, users were able to borrow printed materials on-site with limited hours and strict protocols and return items at a drop-off point or via shipping or circulation desk, or self-check machines and book carts with the reopening lockdown gradually for low-contact deliveries and returns of physical items. With library spaces fully open for the fall semester of 2020, many libraries are winding down book mailing services and 'click and collect' or pick-up borrowing; circulation service is back up to pre-pandemic levels; and varying policies and responses that libraries purchase more UV machines to suggest users decontaminate physical materials themselves (for example, Wuhan University Library purchased more than twenty new UV machines); and extreme cleaning, disinfection, and safety measures are adopted by libraries.

#### Course materials

In China, textbook affordability has long been generally purchased and distributed to students and staff by the textbook unit affiliated with the Academic Affairs Office or Library. The average undergraduate will spend around ¥2000 on textbooks over four years. All the sampled libraries' textbooks and reference collections for courses usually go into the regular circulating collection. Hence, print, and electronic textbook demands were not very high before the spring 2020 semester, when fewer libraries (9.6%, 5/42) introduced electronic reserve systems or textbooks portals, and only one institute provided access to e-textbooks

<sup>1</sup> A mini app was launched by the State Council, was jointly launched by the China Academy of Information and Communications Technology (CAICT), China Telecom, China Unicom and China Mobile. The big data of three basic telecommunications operators is utilized to provide itinerary inquiry services for mobile phone users across the country. It supports one-click inquiry of the countries (regions) and domestic cities (stays of more than 4 h) that have been visited within 14 days. It presents three colors: red, high-risk areas and medium-risk areas in the past 14 days; yellow, any epidemic-stricken country (region) in the past 14 days; green, not been to the above destinations.

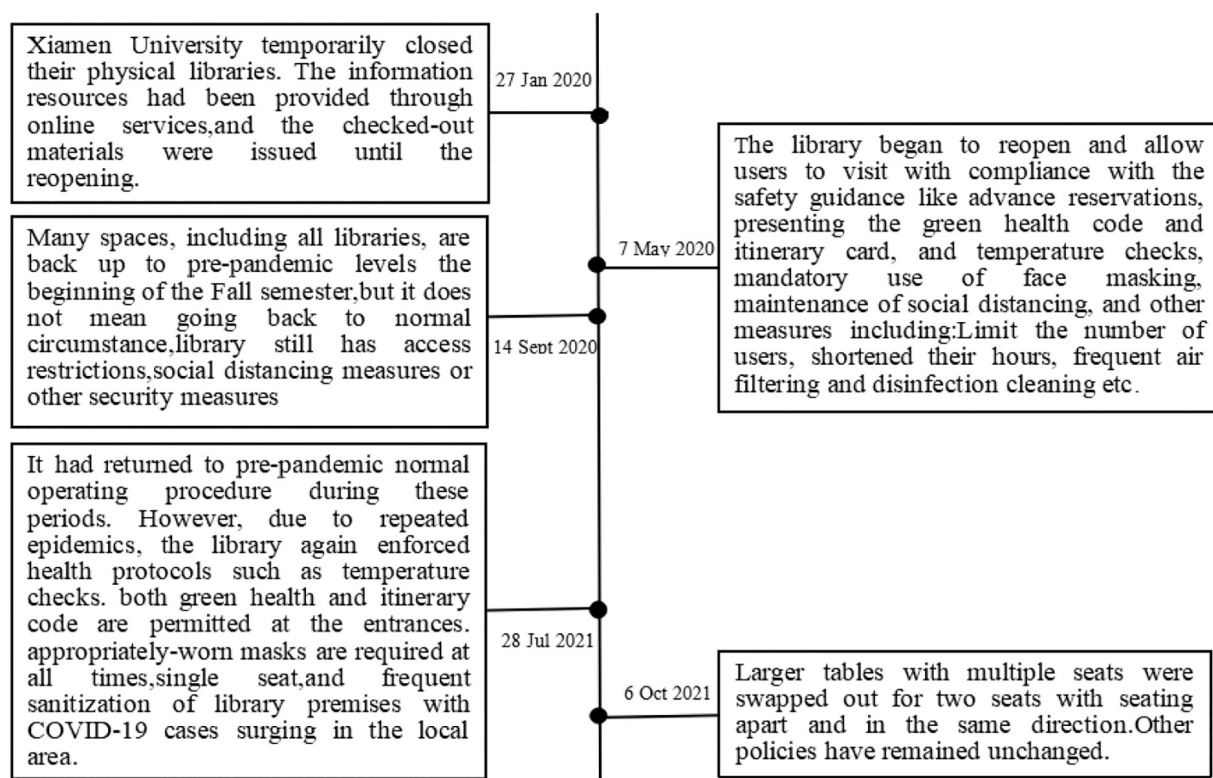


Fig. 1. Xiamen University Library COVID-19 response beginning January 27, 2020 (own work, reference from Thorpe & Howlett, 2021).

to all faculty and students through an electronic reserve system integrated into the university's Learning Management System, Canvas, this institute is Shanghai JiaoTong University Library (SJTU, 2022).

Unfortunately, due to the COVID-19 epidemic, students can't return to school during the lockdown period of the spring 2020 semester, students can't get physics course materials and textbooks issued by schools as before, at the same time, almost all schools start online courses. Many, though not all, academic libraries have attempted the enhancement of their textbook programmes since February 2020. One-quarter of all libraries develop textbook portals in cooperation with the Academic Affairs Office, the Graduate School, and a variety of e-book vendors. Over half (61.9%) of the sampled libraries compile a list of subscription e-book databases and expand databases to include more open access resources and free trials. For example, Tianjin University Library negotiates its subscription licenses with the suppliers of online content as well as increases the subscription rates particularly for textbook material. Meanwhile, because many commercial digital content providers and vendors have made proprietary digital content freely available to public or university audiences for a limited period, libraries also collect and compile a list of free e-resources for faculty and students. In addition, as a supplement, some libraries also support the Scan & Deliver Request Library Materials service, for example, the Library of Shandong University and University of Science and Technology of China updated the function of OPAC, and set up a scan-and-send service where e-books are unavailable, users can access digital extracts of book items through the OPAC interface and loan it as a PDF attachment to the requester's inbox (see, Fig. 2) while 100% of libraries offered electronic textbooks as of November 2020 and continue to enhance. After that, academic libraries deliver printed course materials, such as the Chongqing University Library and the Peking University Library mentioned above, after the user's request, the librarian prepares the materials, and delivers the printed materials by extracting at the designated place or postal services, initiate digitization initiatives and provide online access to course materials contents in digital formats, subscribe to multilingual e-book databases, support inter-library loan

(IIL). In addition, some libraries even developed an electronic reserve system or textbooks portal, for example, The textbook portal of Xi'an Jiaotong University was launched on March 25, 2020 for more than a thousand courses that integrate the I-textbook e-Textbook database.

#### Inter-library loan (IIL) and document delivery

There are four of the most influential library consortia and resource sharing projects in China, including CALIS (China Academic Library & Information System) (similar to Online Computer Library Center, OCLC World Share ILL), CASHL (China Academic Social Science and Humanities Library), NSTL (National Science and Technology Library) and CADAL (China Academic Digital Associative Library), and some local university resource sharing programmes like BALIS (Beijing Academic Library & Information System) and FULINK (Fujian Province Academic Digital Library Consortium), as well as several commercial databases such as BLYUN Library, before the COVID-19 outbreak, they widely supported IIL and document delivery. But with the COVID-19 outbreak, at the beginning weeks of COVID-19, most of the IIL and document delivery services (DDS) will be suspended, especially of print materials, because all were dependent upon the opening of other institutions. For example, DDS was unable to provide scans of onsite materials, ILL was no longer able to request physical materials. However, as staff slowly returned to their institutions for reopening and postal recovery, print ILL became increasingly available through May 2020, fulfilling requests whenever possible. Whereas requests for electronic journal articles and items were still able to be delivered by the above lending systems and networks throughout this period, there may be a delay compared to before. In the meantime, the majority of libraries (84%) of the sampled libraries announced the existing established WeChat and QQ groups for document delivery services.

#### Remote access

The research found that all academic libraries already provided their patrons with remote access to digital resources before the pandemic. As per the data, 90% of libraries mostly implemented the SSL VPN (Secure



Fig. 2. Scan & send request library materials by OPAC. (Screenshot source: <http://opac.lib.sdu.edu.cn/>)

Sockets Layer Virtual Private Network), followed by WebVPN (requires no installation and configuration, 71%), Single Sign-On (SSO) authentication (52%), managed by the University Office of Information Technology, Library e-Resources Remote Access System (43%), proxy technologies like RemoteXs or EzProxy (14%), and other methods such as username & password with authentication via the institution or institution email registration for vacation access by databases offering, and among the few libraries adopting OpenAthens/Shibboleth credentials remote access service. To enable access to the subscribed resources for off-campus users, the majority of libraries (60%) have acquired different types of remote-access tools (no more than three). It is interesting to note that at least one institute only allows graduate students and full-time faculty members to use VPN support. They need to apply for VPN accounts because the VPN infrastructure has a limited capacity.

In response to COVID-19, all libraries require a series of work-arounds between the library, the IT department, and outside providers/vendors to make e-resources available for off-campus access. Specifically, the extended and enhanced remote access approaches include: (1) Frequently announcements or update notices on the library websites and social media to library users about remote access. (2) Some libraries extend the server capacity and improve the quality ICT infrastructure of VPN. (3) Adopt new remote access tools, for example, CARSI<sup>2</sup> (CERNET Authentication and Resource Sharing Infrastructure), WAYFless (Where Are You From Less), Smart Library SSO Sign In, MyLOFT plug-in. Among them, CARSI has the most extensive influence, as of March 12, 2020 among the sample libraries, 37 academic libraries (88.09%) have joined CARSI, as April 5, 2020 all the sample academic libraries have joined CARSI. Through CARSI, users can directly access part of subscribed resources anywhere outside the campus without confirming their identity through the campus IP address and using VPN, libraries can avoid the congestion and delay caused by the use of a VPN. Beyond that, publishers and database vendors' have made efforts, publishers opened their resources for free online access during the pandemic, and users can remotely access through a personal registered account (see, for example, SAGE Journals, 2021).

Reference services

In pre-pandemic times, reference services were carried out through traditional library consultation (i.e., in person at a reference desk or face-to-face with a librarian) and online virtual reference services (VRS). Most participants reported that VRS was in place pre-COVID, including social media tools (i.e., QQ Live Chat, QQ Group, and WeChat group, WeChat Official Accounts and microblog) to deliver instant messages and documents, answer queries, or by phone, email to the library or a

<sup>2</sup> CARSI is a shibboleth-based and single sign-on-based (SSO) mechanism for remote access developed by China Education and Research Network (see, [https://www.carsi.edu.cn/index\\_en.html](https://www.carsi.edu.cn/index_en.html)). More than 50 commercial databases offer CARSI remotely access, such as Springer, EBSCO, Emerald, IEEE, RSC, etc.

liaison librarian or director, submit the web form query, search FAQs, BBS, etc. In addition to the above reference approaches, the study found that 5 academic libraries already provide their patrons with artificial intelligence reference robots 24/7. All libraries closed their reference desks and suspended face-to-face consultations at the beginning of the pandemic and early reopening period. Reference services continued to provide online assistance remotely through already-established chat and email services during regular library hours or even longer hours to respond to users' reference queries and engaged in online users. To accommodate the "new normal (Corpus, 2021)," apart from in-person and online references, another six libraries also offer online reference services via artificial intelligence Robot chat interface to provide responsive reference support anytime, it can also be transferred to librarian references chat or texting during regular library hours, during the investigation, the author found that Robot is not intelligent enough, the author's team asked the artificial intelligent Robot questions, and found that some answers did not conform to the industry conventions, and then the author's team asked the same questions through online librarian references, and the answers received were different from those of the Robot.

Information literacy instructions and other activities

Pre-COVID-19, face-to-face instructions were dominant among all libraries, with almost all information literacy lectures (i.e., seminars or workshops or training or freshman orientation) and information literacy courses (including undergraduate and postgraduate curricula) offered in person. Whereas fewer libraries (7.1%) also offered online virtual instruction, which can be in the form of asynchronous (such as the video and web tutorials and other materials provided) (see Table 1). The data in Table 1 shows that all institutes suspended in-person library instruction sessions during the COVID-19, approximately 95.2% of libraries offered online instruction, which was available either synchronously (95.5%) or asynchronously (19%) during the pandemic. It was discovered that information literacy training was delivered via online instruction platforms, such as Tencent Meeting, Zoom, Bilibili (a social media platform similar to YouTube), DingTalk, Rain Classroom, Blackboard, and others. Virtual instruction and workshops are available either as live sessions in the synchronous sessions or replays of recorded video live broadcasts using mobile devices or computers. It should be noted that most (95.24%) libraries created video tutorials for instruction

Table 1

Total number of libraries offering ILI by in-person, asynchronous, or synchronous methods in three phases.

	In-person		Asynchronous		Synchronous	
	N	Percent	N	Percent	N	Percent
Prior stage	42	100	3	7.1	0	0.0
During stage	0	0.0	8	19.0	40	95.2
Normal stage	36	85.7	12	28.6	32	76.2

purposes gradually from March or released the previously produced video mini-courses. For example, in January 2021, Peking University Library launched the “Video Mini-tutorials for Information Literacy Education” which contains a number of short and concise micro-video tutorials (5–10 min) on how to use the library’s resources, the EndNote citation tool, as well as plagiarism and academic integrity, etc. asynchronous content (Peking University Library, 2021). Tsinghua University Library designed and launched the special webpage “Micro-video of Information Literacy Instructions” (see, <http://mclass.lib.tsinghua.edu.cn/>), and Renmin University of China and East China Normal University also introduced instructional videos on their websites on emerging research and other topics and promote libraries. Going forward, the majority of libraries (75%) will offer hybrid instruction and workshops in a synchronous face-to-face format and supplement online live sessions or replay asynchronously recorded videos, while the remainder of libraries will be most likely to be offered in-person experiences more frequently, or supplement remote instruction sessions as well as the option of already established custom research guides, tutorials, and videos. Similarly, previous in-person events and activities such as discussion forums and reading promotion programmes were either cancelled or pivoted to virtual events (i.e., virtual reading events or online book clubs) during the pandemic, and they will most likely continue to be offered in online form, or supplement in-person formats more frequently with social distancing and mask-wearing.

#### *The summary changes of facilities and procedures*

The facilities and procedures for safety measures and procedures are reported to be the most changed operational processes throughout participating institutions. Facilities and procedures that improved safety (infrared thermometers at the entrance for temperature checks, one-meter mark line and plexiglass to maintain the required distance, hand sanitizers and disinfectants for diligent cleaning and disinfection) were increased as shown in Table 2. Table 2 highlights the results of the research and shows the added facilities and operational procedures implemented during COVID-19. These changes also helped streamline processes in a new normal and post-pandemic academic library environment, especially when COVID-19 cases surged again locally and concern further increased. It was decided in the interest of health safety that the library continue to strictly adhere to COVID-protocols. Almost half (45%) of library release notices were to further strengthen epidemic prevention and control measures, and 7.1% of libraries closed completely again after fully reopening. For example, on 25 January 2020, Zhengzhou University Library was temporarily closed in response to the crisis, partially opened (for few hours) with limited services and limited access on 8 May 2020, and fully opened on 22 August 2020. Libraries had to close once more on 4 August 2021, and were reopened on 9 September 2021 closely following strict health protocols and adhering to university safety guidelines (Zhengzhou University Library, 2021). After completing the draft paper in mid-December 2021, COVID-19 cases spiked in Xi’an, Northwest China’s Shanxi province, Xi’an Jiaotong University Library, among the sampled academic libraries, strictly followed the protocol to both safeguard the safety and continue to serve their communities at the beginning two weeks of COVID-19 outbreak. While library physical buildings were closed in keeping with the government mandate on Dec 28, 2021 and translated to a quick pivot to support services and programmes that moved to almost-exclusively online and remote for all patrons, and encouraged patrons to use digital resources when possible and announced that the loan period was extended until one week after opening (Xi’an Jiaotong University Library, 2021). Generally speaking, if there is another small-scale outbreak of COVID-19, the library will swiftly and seamlessly be pivoted or shifted turn to providing service with little or no personal contact or online-only service.

**Table 2**

The new or extended facilities and equipment and operation procedures during COVID-19.

Safety measures	Facilities and procedures
Access by appointment only	People are required to make an appointment via booking reservation system in advance of a visit
Check patron body temperatures and QR health codes	All individuals are required to check their temperature by non-contact infrared thermometers at the entrance, body temperature above 37.3 °C is not permitted to enter the facility. All individuals are required the use of apps (Health Check Daily pass or itinerary card) on personal devices for such screening, They can only enter the building with a “green” screen.
Wear a face covering	It is compulsory for everyone to wear a face mask at all times
Social distancing requirement	Install physical dividers or plexiglass shields, change the layout and one-way routes, arrange seats to maintain proper social distancing
Ban on food and inflammable and explosive materials	It is forbidden to bring food or eat in the building (4/42), and four libraries ban the brought inflammable and explosive materials such as alcohol, disinfectant into the site for fireproof safety, and disinfectant wipes are allowed to wipe the armrests and seats.
Cleaning, & infection safety measures	Facilities such as doorknobs, elevator buttons, etc. all hard surfaces are being regularly disinfected Nine libraries’ air-conditioning or elevators were used in accordance with the epidemic prevention regulations or stopped running or turned off, and open windows to let fresh air into the building 3 times a day Quarantining returned books for a specific period of time Book sterilizers with UV are purchased more or newly acquired for patrons used to decontaminate physical materials Hand sanitizers were provided at the entrance and in different areas of the library buildings for everyone. Staff are equipped with disposable gloves and alcohol-based hand sanitizer
Remote access facilities	Enhance ICT infrastructure and extend the VPN capacity Update OPAC for request an item for a selected location or PDF, see Fig. 2 Update details of services guides, COVID policies, e-resources and printed materials access means on library webpages and social media

## Discussion

The purpose of this study is to ascertain the state of library space, collections, and services prior to and following the COVID-19 epidemic outbreak. It aids in determining how to adapt to the epidemic and in discussing these adaptations item by item in light of research findings.

### *Library space arrangements*

Prior to the epidemic, university libraries completely opened their spaces and provided a variety of space services. During the initial stages of the COVID-19 epidemic, all of the university libraries investigated closed their physical spaces and restricted access. Later, as the COVID-19 epidemic was successfully contained, the extent of library space opening gradually increased. But this was accompanied by a variety of epidemic prevention and control measures, including social distinguishing measures, cleaning and sanitizing procedures, as well as health screening procedures, are all included. Following that, several libraries closed and reopened again due to a small-scale outbreak of a local epidemic situation. In short, whether the library space is open or not, and the extent to which it is open, as well as the accompanying safety measures, must be



quickly adjusted in accordance with the development stage of the epidemic situation. In comparison to previous research, the findings of this study clearly indicate whether or not the library space is open or closed. It also helps to determine to what extent it is open varies significantly before and after the outbreak of the epidemic and at various stages of the epidemic's development. Throughout the investigation, there was a transition from fully open pre-pandemic to the early period of the COVID-19 lockdown. Then, a transition from reopening (from partial reopening, modified opening, and full open status) with COVID-era restrictions, and/or individual institutions closing and reopening again. Librarians' workflows needed to be adjusted during a period of high uncertainty and stress (Salvesen & Berg, 2021). Also, libraries responded to space and access issues in a variety of ways (see details for the subsection on [Physical space and precautionary measures](#) and [Table 2](#)). Thus, the primary goal of reopening was to make the library as safe and clean as possible and to improve user experience during and post-pandemic.

The library is a communal space where students can study quietly or in groups, as well as a social space where they can collaborate and socialize with their peers. According to the survey, spaces have been significantly impacted by the COVID-19 pandemic, closures, and reopening with restrictions, such as a decreased capacity for each of the table study areas and group study rooms. As was the case prior to COVID-19, many libraries have actively worked to make their spaces more flexible and open (i.e., more casual seating, mobile furniture, and food and drink permitted) (Farne et al., 2021), and group study rooms were one of the most frequently used library spaces (Ojennus & Watts, 2017; Scoulas & De Groot, 2019). As Farne et al. (2021) correctly stated, "the move toward tighter restrictions may have had an effect on students' desire to visit the library,". Also, a recent study by Garnar and Tonyan (2021) demonstrated the library's importance as a place in the future in the context of online teaching and remote access resources. To offset these negative effects, measures to improve safety (air filtering, sanitation supplies, and cleaning). As well as redesigning library furniture in accordance with health protocols evolved over time (more single seats, interaction with others), and a greater emphasis on 'good views' (i.e., 'aesthetic appearance' and 'window views' spaces located near windows). These things enhance positive emotions and are a significant component of satisfaction (Cha & Kim, 2020; DeClercq & Cranz, 2014; Hegde et al., 2018; McGinnis & Kinder, 2021). Numerous studies, including those by Garnar and Tonyan (2021) and McGinnis and Kinder (2021), observe that it depends on our ability to instill the same sense of purpose and inspiration in learning, creativity, and interactions in the new normal of social distancing. And that libraries should play a role in making libraries "the place to be" — a vibrant, dynamic, interactive hub of the campus community.

#### *Collection development transformation*

The second transfer that academic libraries may face is in the area of collection development. Prior to the COVID-19 outbreak, university libraries developed printed collections primarily through on-site and online procurement, supplemented by reader-driven procurement. Following the COVID-19 epidemic outbreak, the majority of libraries discontinued on-site procurement of printed collections in favor of online procurement and DDA/PDA. Simultaneously, the volume of printed collections procured decreased, while the volume of digital collections expanded. In detail, the survey results indicate that a large number of university libraries have either abandoned their traditional on-site materials acquisition model or shifted to online acquisition programmes through online book exhibition. Additionally, between 2020 and 2021, ordering websites developed by "The National Library Distribution Alliance" (Book vendors/distributors) assigned each library an account and attempted to acquire print books remotely through patron- and librarian-selected purchases. Meanwhile, the vast majority of participants who had established "users' loan from partner bookstore online or

in-store, library purchase of books" were able to seamlessly transition to an online-only service, supplementing more traditional librarian selection (Arthur & Fitzgerald, 2020; Goedeken & Lawson, 2015). These shifts reflect the need to support a variety of collection development efforts, including traditional collection development and established and enhanced demand-driven acquisitions, in addition to other new initiatives to meet patron needs in a "new normal" (Corpus, 2021). However, there is a dearth of literature describing the printed collection development methods used during the pandemic. This study focuses on new acquisition models and technological applications for libraries during and post-COVID-19 crisis. Such as the well-established national virtual platforms for patron and librarian-selected materials in the last two years and the widely used online DDA/PDA partner with bookstore programmes, and they will be promoted and used widely in China.

Although the library had a robust digital content offering prior to COVID-19 and concentrated efforts on promoting existing electronic resources and enhancing their digital collections. The study's findings indicate that the majority of course-required textbooks are either not available in the databases or are scattered across multiple e-book databases. The reason for this may be the affordability of paper textbooks and the lack of universal online courses (e.g., MOOCs or via Zoom and/or Blackboard) in China prior to COVID. Libraries make significant efforts to provide and acquire additional digital content, particularly textbooks. It also helps to compile a list of free electronic materials provided by content vendors and publishers, as well as links to subscribed electronic book databases, for faculty and students during the crisis. This situation demonstrates a lack of national awareness regarding the benefits of online teaching and e-textbook reserves. Despite the fact that a few Chinese academic libraries have implemented textbook portals and integrated them into the university's Learning Management System. These findings are consistent with those of Steele (2021), who discovered a dearth of embedded librarians engaged in the design or development of online courses. In the 2021 academic year, many courses will remain online, particularly during the first two weeks of the semester or after all courses have been moved online in response to pandemic outbreaks, or will be held in a hybrid format due to sporadic local outbreaks. Liaisons between libraries and courses can assist with online teaching by developing an electronic reserve system and expanding course resources, such as links to textbooks and other materials. Additionally, the library promotes open educational resources (OER) materials (Mehta & Wang, 2020; Murphy & Shelley, 2020). In the future, the Chinese academic library will support college curricula by providing an increasing amount of required reading content in digital format for remote access by patrons and by creating or utilizing open educational resources (OERs) (Kiriakova, 2021).

Generally, existing studies note that the use of digital collections increased significantly following the outbreak of the COVID-19 epidemic and that digital collections have developed. But these do not go into detail about collection development priorities and collection procurement methods prior to and following the epidemic. This study examined this point in sufficient detail.

#### *User service shifts*

The results showed that before the COVID-19 pandemic, Chinese academic libraries provided information services such as printed materials and digital collections on-site and remotely off-campus via hybrid means. And also, services include circulation, inter-library loan, and document delivery services, reference services (traditional consultation and virtual references), face-to-face information literacy instructions (i.e., on-site workshops, user education, freshman orientation, and courses) among others. Also, it was observed that the collection and services were print-based and physically oriented. Like other countries' libraries (see, for example, the reports of the [American Library Association, 2020](#); [IFLA, 2020](#)), Chinese libraries responded quickly to the new circumstances within the expansion of a significant number of services,

including the remote access of e-resources and innovative outreach activities (enhanced online presence, one-spot access to all resources). New services included zero-contact services (e.g., “click and collect” or pick-up borrowing or book delivery services or scan-and-send services) and certain types of virtual programming and events (i.e., VRS and online instruction sessions) while continuing to serve the university community through all available channels (website, social media accounts, e-learning platforms), that is libraries were never “closed”. The transition to digital services had been occurring, however, COVID-19 accelerated the process (Pryce et al., 2021; Temiz & Salekar, 2020; Thorpe & Howlett, 2021). This required the need to strengthen IT infrastructure and librarians’ digital literacy/skills (Chakraborty & Jana, 2021; Runyon & Steffy, 2021; Winata, Fadelina, & Basuki, 2021), while ensuring the library staff adapts to the new normal (Mbambo-Thata, 2021), offers high-quality online services (i.e., hybrid mode of information literacy sessions and reference services), is involved in the design or development of online courses (Steele, 2021), and reaching out to faculty and students more effectively and innovatively (Mehta & Wang, 2020). In addition, there is a growing trend around the societal responsibilities and role of academic librarians, including tackling misinformation and fake news (Rafiq et al., 2021; Tamaro, 2021), supporting student mental health and well-being (Bladek, 2021; Cox & Brewster, 2020), and promoting reading habits and good reading material to help people in isolation (Rafiq et al., 2021). Generally speaking, the existing studies and this paper have introduced the great changes of library services after the outbreak of COVID-19, such as canceling face-to-face consultation and providing online information literacy sessions, etc. But this paper also detailedly introduced the contents and characteristics of library services before the COVID-19 epidemic, and pointed out that before the epidemic, library services showed online and offline mixed services characteristics, which highlighted the epidemic has accelerated the digitalization of library services.

This new normal creates and opens a new window of opportunities to establish library services with innovation and evolving information technology. For example, this pandemic increased awareness about library resources and services, and people are realizing the significance of these digital library services more than before (Mehta & Wang, 2020; Rafiq et al., 2021). The pandemic triggered reflections and created opportunities for university libraries to rethink how they engage creatively with their communities (Rafiq et al., 2021; Smith, 2020; Thorpe & Howlett, 2021). For example, Chinese libraries have implemented a number of safety protocols to mitigate the spread of COVID-19 and safeguard the health and well-being of staff and students when they develop more contactless-oriented services and online services and content during COVID-19 and new normal era. Also, it was observed that great challenges due to the protracted period of the pandemic exist because there are significant budget limitations in place and the uncertainty of epidemic outbreaks repeatedly and sporadically with new coronavirus variants (Omicron, Delta COVID-19).

The following are the reflections on what can be considered for development now and in the future based on findings and previous studies, the authors recommend that libraries (1) create comprehensive disaster planning and emergency preparedness in cooperation with libraries around the world (Kehnemuyi, 2021; Wijayasundara, 2021); (2) implement sustainable, permanent changes to library services and operations (Heady et al., 2021; Runyon & Steffy, 2021); (3) embrace digital tools and technologies like enhance remote access infrastructure and digital skills, intentionally integrate more digital resources into the collection and more virtual services into the workflow; (4) develop a unique repository collection that can archive and preserve the practices, thoughts, events and literatures of experiencing the unprecedented situation around COVID-19 and previous disasters where future generations can learn from past generations (Farne et al., 2021; Mehta & Wang, 2020), and finally, (5) develop emergency management of the “new normal” agenda for librarianship both as part of their course requirements and as compulsory industrial training among Library and

Information Science undergraduates that prepares them for becoming library and information professionals. As Heady et al. (2021) discuss, rather than a return to a pre-pandemic normal operating procedure, this can be a time to innovate and create a new normal that positions academic libraries to better weather future storms.

### Limitations

There are several limitations to this study that should be mentioned. First, this study mainly relied on websites and social media reporting of the top 42 academic libraries. In the data collection stage, there are many other activities and services that university libraries are offering to their communities that might not have been noticed. Moreover, the information provided by some websites and social media is obviously missing or not updated in time. The author’s team contacted librarians to obtain supplementary records of relevant information, but there is no guarantee that the contacted librarians will know all the measures of their libraries, which may affect the accuracy of the research results. After that, we may join forces with influential institutions, such as the relevant responsible personnel of the Library Society of China, this institution is approximately equal to ALA, to cooperate with them and rely on their appeal to obtain detailed work reports of university libraries during the COVID-19 epidemic, to ensure the complete research materials, in addition, in the future, we will collect the views of users and librarians on these changes. Finally, we desired to be as detailed and comprehensive as possible but changing circumstances and protocols and two years wide span made it difficult to write, although it may not affect the overall snapshot and picture of how academic libraries in China are responding to and coping with a rapidly changing environment.

### Conclusion

The COVID-19 epidemic has brought many challenges to the operation of university libraries. This study analyzed the performance of 42 university libraries in dealing with COVID-19 at different stages and found that the COVID-19 pandemic influenced university libraries in physical space, collection development, and service. In order to prevent and control the COVID-19 epidemic, many facilities and equipment for safety measures and procedures have been added, and university libraries have been actively making adaptive changes and taking corresponding countermeasures. In terms of library space, it has been adjusted according to the epidemic situation. In terms of collection development, online purchases of printed books are supported, and then book suppliers deliver books to users, and digital collections are greatly enriched. In addition, although the library continues to provide services for users, many changes have taken place in the service mode, such as strict circulation of printed books, provision of electronic textbooks, enhancement of inter-library loan and document delivery, remote access, online and artificial intelligence reference services, online information literacy instructions and so on. These adaptive change measures can better cope with the challenges brought by the COVID-19 epidemic. Even in the ever-changing epidemic, university libraries try their best to meet the needs of users and play an important role in the life and study of users, as Mehta and Wang (2020, p362) indicated: “...the global pandemic has not and will not rattle the essential role of a university library that provides support for faculty and students who teach and learn on-campus or off-campus before, during, and post the global crisis.” To the best of the researcher’s knowledge, this is an early attempt toward a holistic snapshot to explore a transition shift from prior to the normal COVID-19 on the topic of physical space, collection building, and service provision at top academic libraries in China. Together, the three phases of this research will not only inform libraries’ outreach and development efforts but will also pave the way for future research around the evolution of academic library space, collections, and services in a post-COVID world. Academic libraries will continuously develop

innovative ways of sustaining and scaling physical and digital library provisions and various onsite and online services and programmes offerings. This study is also helpful for libraries to deal with the COVID-19 pandemic and similar public health crisis events. These findings and results can provide a reference for libraries to formulate corresponding policies and procedures during the epidemic of COVID-19.

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## CRedit authorship contribution statement

**Qi Kang:** Conceptualization, Methodology, Formal Analysis, Writing – Original Draft.

**Zhiqiang Song:** The corresponding authors, Conceptualization, Methodology, Writing – review & editing.

**Tingting Shi:** Data Collection, Writing – review & editing.

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