Embracing open science: understanding data sharing practices, benefits, and challenges at the Malaysian National Institutes of Health

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ABSTRACT

This study examines research data sharing practices as a core element of open science at the Malaysian National Institutes of Health (NIH). Using a qualitative research design, semi-structured interviews were conducted with seven heads of departments and units across various NIH institutes and divisions. The study aimed to explore the extent of engagement in data sharing, the perceived benefits of open science, and the challenges faced in implementing such practices within the institutional context. The findings reveal that, while there is general awareness of open science principles, actual data sharing remains limited, with most researchers restricting dissemination to open-access publications. Key benefits cited include enhanced research collaboration, increased visibility and citations, improved transparency and accountability, and greater resource optimisation through reduced duplication. However, significant barriers persist, including inconsistent data management practices, lack of clear ownership guidelines, limited awareness and training, stakeholder sensitivities, and a performance evaluation system that does not reward data sharing. Participants proposed several strategies to address these gaps, including targeted capacity-building initiatives, clearer data-sharing policies, performance-based incentives, upgrades to technical infrastructure, and stronger leadership support from top management. This study provides valuable insights into the organisational and cultural conditions that shape the adoption of open science in Malaysia's health research sector. The findings have practical implications for policymakers, institutional leaders, and researchers seeking to foster a more transparent, collaborative, and impactful research environment through open science.

Keywords: *Open science; Data sharing practices; Data sharing benefits; Data sharing challenges; Malaysian NIH.*

INTRODUCTION

With rapid technological advancement and increasing global connectivity, research institutions are recognising the importance of collaboration and interoperability in advancing knowledge. Open science practices enable researchers to build on each other's findings, fostering interdisciplinary collaboration and more impactful research. A notable example occurred during the COVID-19 pandemic, when researchers worldwide rapidly shared the SARS-CoV-2 genetic code, enabling swift vaccine and diagnostic development. Edward Holmes of the University of Sydney was later honoured with the 2021 Prime Minister's Prize for Science for leading this effort (Cathy, 2021, 6 December). Among the core elements of open science, data sharing plays a vital role in promoting transparency, integrity, and innovation (Ahmed et al., 2025). In public health and biomedical research, timely data access supports rapid responses to health crises (Besançon et al., 2021; Hak, Abelha, & Santos, 2020). Despite their central role, many research institutions still limit data sharing to internal networks, with little use of open repositories (Read et al., 2021; Wibowo & Mon, 2025). For example, Chen et al. (2024) found that only 10.3% of investigators intended to share participant-level data, and even top institutions showed low uptake of sharing tools (Hall et al., 2024).

As illustrated in Figure 1, several studies on motivations and barriers highlight key drivers of data sharing, including advancing science, collective knowledge, professional recognition, and access to repositories (Ahmed et al., 2024; Wibowo & Mon, 2025). Training and awareness initiatives also encourage participation. However, barriers such as privacy concerns, ethical restrictions, and weak policy enforcement persist (Byrd et al., 2020; Parker & Bull, 2015). Despite mandates from funders and journals, compliance remains inconsistent (Tan et al., 2024). Therefore, effective data sharing requires balancing public benefit with privacy and institutional trust.

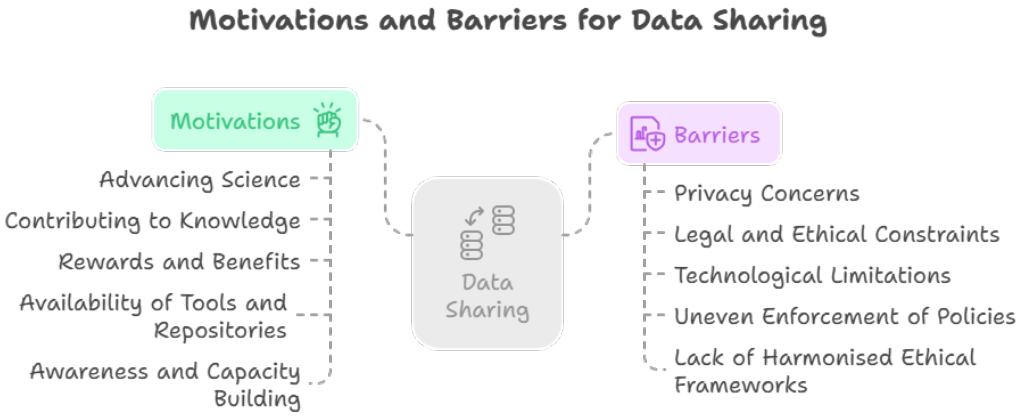

Figure 1: Motivations and barriers for data sharing

In Malaysia, the National Institutes of Health (NIH), established in 2003, plays a leading role in national health research (National Institutes of Health, 2025). The Malaysia Open Science Platform (MOSP), launched by the Ministry of Science, Technology and Innovation (MOSTI) in 2019, promotes the FAIR principles (Findable, Accessible, Interoperable, Reusable) (Akademi Sains Malaysia, 2019). To support this initiative, the NIH introduced NIH-DaRS in 2021 as an institutional data repository. However, adoption has been low: out of more than 500 publications in 2021/2022, fewer than ten datasets were deposited. This

limited participation, despite existing infrastructure, highlights the need to understand the institutional, cultural and operational factors affecting data sharing. Therefore, this study examines data sharing practices at the Malaysian NIH to inform strategies for strengthening open science implementation within Malaysia's health research landscape.

LITERATURE REVIEW

Open science has attracted global attention as a movement promoting transparency, accessibility, and reproducibility in research. Central to this movement is data sharing, which enables the dissemination and reuse of data, fostering collaboration and accelerating scientific discovery. As Mahony (2022) notes, open science represents a shift from isolated research towards a more interconnected and participatory model of knowledge production. Key components include open-access publishing, open peer review, and open data repositories (Ahmed & Othman, 2021b). These practices support validation, replication, and broader use of scientific outputs (M'kulama & Akakandelwa, 2021). According to UNESCO (2023), open data sharing increases research visibility and impact, while facilitating interdisciplinary collaboration across institutional and national boundaries (Zhu, 2020). Beyond academic benefits, data sharing strengthens public trust through increased transparency and accountability (Ünal et al., 2019). However, challenges such as privacy, misuse, intellectual property concerns, and limited technical capacity often discourage open sharing (Hodonu-Wusu, Noorhidawati, & Abrizah, 2020; Saeed & Naushad Ali, 2019). In resource-limited settings, organising and preserving datasets can also be challenging (Suhr, Dungl, & Stocker, 2020). To address these barriers, effective Research Data Management (RDM) is essential for ensuring data quality, integrity, and accessibility throughout the data lifecycle (Bordelon & Starry, 2025). RDM aligns with the FAIR principles (Findable, Accessible, Interoperable, and Reusable) (Wilkinson et al., 2016), which enhance data discoverability and usability, supporting the broader goals of open science.

Data sharing is increasingly recognised as essential for enhancing the quality, integrity, and societal relevance of scientific research. Within the open science framework, it promotes transparency, reproducibility, and collaboration, enabling researchers to build on existing work, minimise duplication, and accelerate innovation, particularly in health and biomedical research, where timely access to data supports clinical and public health decisions (Ahmed et al., 2024). A major motivation for data sharing is the advancement of science and collective knowledge creation. Shared data fosters collaboration, new insights, and interdisciplinary research (Wibowo & Mon, 2025). According to Allen and Mehler (2019), open science practices such as sharing datasets and methods enhance trust, transparency, and reproducibility, while also offering reputational benefits, including higher citation rates and peer recognition. Institutional policies play a crucial role by embedding openness into research norms. Cook et al. (2022) highlight that structured approaches such as pre-registration, open-access publishing, and reproducible workflows help operationalise open science across disciplines, including health research. Similarly, infrastructure such as data repositories and preprint servers (Besançon et al., 2021; Curioni & Gil, 2024) reduces technical barriers and facilitates rapid dissemination, allowing for peer validation and increased research credibility. Overall, these motivations illustrate how open science and data sharing create a more collaborative, innovative, and trustworthy research environment.

Despite its benefits, data sharing faces multiple challenges that limit adoption, particularly in health and biomedical research. These barriers arise at legal, ethical, technical, and institutional levels, often overlapping to discourage researcher participation. At the individual level, early career researchers encounter structural disincentives such as a lack of formal rewards, limited training, and academic cultures that prioritise publications over open practices (Allen & Mehler, 2019). Open science activities such as data curation or pre-registration also require considerable time and resources, which may be unrealistic without institutional support (Banks et al., 2019). At the institutional level, obstacles include unclear data governance policies, inadequate infrastructure for secure data storage, and insufficient training in data stewardship. Researchers also fear reputational risks from sharing incomplete datasets (Dezhina, 2023) and face complex legal and ethical issues concerning patient confidentiality, intellectual property, and collaboration agreements. Policy inconsistencies further complicate the landscape. Although many journals and funders require data availability, enforcement remains inconsistent, particularly in low-resource settings. Confusion over anonymisation, metadata standards, and long-term preservation adds to the difficulty (Pujades Corbi, 2023). Unless these systemic and cultural barriers are addressed, the transformative potential of open science will remain limited. Realising its full promise requires coordinated solutions that strengthen governance, training, and ethical standards across the biomedical and public health research sectors.

Although open science has gained global momentum, its adoption varies across countries depending on infrastructure, policy, and institutional readiness. In Malaysia, notable progress has been made with the Malaysia Open Science Platform (MOSP), launched by the Ministry of Science, Technology and Innovation (MOSTI) in 2020 to promote the FAIR principles: Findable, Accessible, Interoperable, and Reusable (Akademi Sains Malaysia, 2019). The Malaysian National Institutes of Health (NIH) has supported this agenda by establishing NIH-DaRS, a centralised data repository launched in 2021 to facilitate research data sharing. Despite these initiatives, adoption has been slow, revealing a gap between policy goals and actual researcher engagement. To encourage participation, MOSP highlights benefits such as increased research visibility, higher citation rates, improved policymaking, and enhanced public accountability, as illustrated in Figure 2.

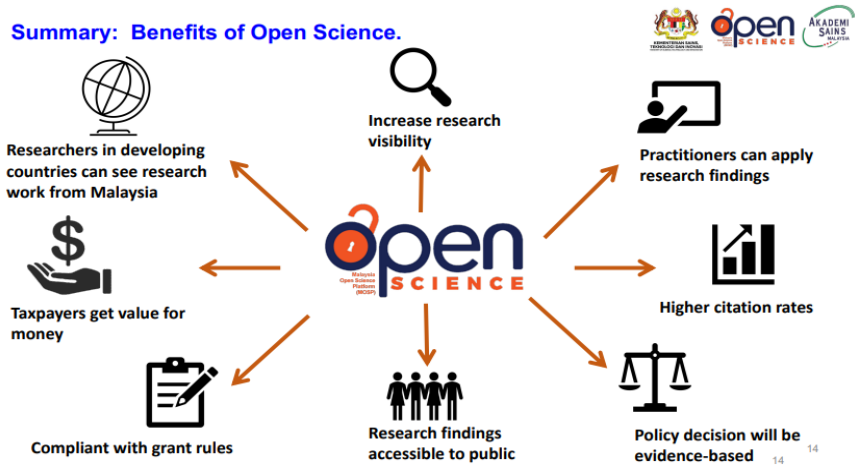

Figure 2: MOSP open science objectives source (MOSP, 2020)

However, studies show that researchers' awareness of and readiness to practise open science remain limited. Ahmed and Othman (2021b) found that most academics were only

moderately familiar with data sharing and seldom used institutional repositories. Similarly, Ahmed and Othman (2021a) and Hodonu-Wusu, Noorhidawati, and Abrizah (2020) reported that insufficient training, limited infrastructure, and policy ambiguity hinder participation. Ariffin and Abd Aziz (2022) further noted that while public servants value open data for transparency and innovation, concerns about data quality and standardisation persist. These findings reveal a consistent gap between policy aspirations and institutional practice, underscoring the need for capacity building and infrastructure investment. Traditional academic evaluations prioritise publications over data sharing, offering little incentive for researchers to curate datasets. Issues of privacy, confidentiality, and data ownership further limit participation (Ahmed et al., 2024). Nevertheless, Malaysia has strong potential to advance open science through coordinated national strategies. This includes improving RDM infrastructure, fostering cross-institutional collaboration, and integrating open science indicators into performance assessments. As noted by Ahmed et al. (2024), sustained leadership, policy clarity, and training initiatives are vital for cultivating an enabling environment for open and transparent research.

Although the literature recognises the benefits of open science and data sharing for improving research quality, collaboration, and societal impact, significant implementation gaps persist in Malaysia. Despite national initiatives such as the Malaysia Open Science Platform (MOSP) and institutional repositories like NIH-DaRS, researcher participation remains low (Ahmed & Othman, 2021b; Hodonu-Wusu, Noorhidawati, & Abrizah, 2020; Ariffin & Abd Aziz, 2022). Many researchers remain uncertain about data ownership, ethical clearance, and institutional support, while the lack of clear mandates, standardised metadata, and performance-based incentives continues to undermine engagement (Ahmed & Othman, 2021a; Tan et al., 2024). The literature further indicates that awareness alone is insufficient. Without institutional commitment through capacity building, infrastructure investment, and leadership advocacy, data sharing will remain inconsistent and reliant on individual efforts. This misalignment between national policy and institutional practice threatens Malaysia's broader research innovation objectives. For organisations such as the Malaysian NIH, which manage large volumes of publicly funded data, addressing these gaps is critical. Institutions must therefore move from advocacy to action by embedding open science into governance frameworks, providing incentives for compliance, and fostering a culture of openness and collaboration. This study contributes to bridging these gaps by offering qualitative insights into how NIH researchers and leaders perceive the benefits, challenges, and strategies necessary for building long-term institutional readiness for open science.

METHODOLOGY

This study explores how data sharing is understood, practised, and perceived across research units and divisions at the Malaysian National Institutes of Health (NIH). It is guided by the following research questions:

1. How do researchers across different units at the Malaysian NIH currently engage in data sharing practices?
2. What benefits do researchers perceive in participating in data sharing within their respective units?
3. What are the key challenges faced by researchers at the Malaysian NIH in implementing data sharing practices?
4. What are the proposed strategies to support and promote open data sharing practices at the Malaysian NIH?

To answer the research questions, this study adopted a qualitative research design to explore data sharing practices, perceived benefits, and challenges in implementing open science at the Malaysian National Institutes of Health (NIH). A qualitative approach was appropriate due to the exploratory nature of the study and the need to capture in-depth, context-specific insights from institutional actors.

Sampling strategy and participant selection

A purposive sampling strategy was used to recruit participants with decision-making or coordination roles in research management. These included department heads and senior officers from research institutes and divisions under the Malaysian NIH. Participants were selected based on their familiarity with research processes and institutional policies related to data management. If unit heads were unavailable, experienced representatives with similar responsibilities were interviewed. Participants were included if they were affiliated with one of the six research institutes or divisions under the Malaysian NIH and held a leadership or research coordination role, such as Head of Unit or Senior Medical/Research Officer.

Data collection procedures

Semi-structured interviews were conducted with seven participants representing different NIH divisions. This sample size was appropriate for qualitative inquiry, where thematic saturation, rather than numerical representation, determines adequacy (Marshall, 1996). Interviews were conducted between July and August 2023, each lasting approximately 60 minutes via online conferencing platforms. An interview guide was developed from relevant literature and refined through expert review by four researchers with experience in open science, health informatics, and qualitative methods, as shown in Table 1. Ethics approval and consent to participate were obtained from the Malaysian National Medical Research Register (NMRR) with approval ID: NMRR ID-23-00287-STC (IIR) and from the participants before data collection. The study was conducted in accordance with the regulations and guidelines in the protocol.

Table 1: Mapping of research questions to the interview questions

S/N	Interview question	Mapped research question
1	Please briefly introduce yourself, your position, your role, and how long you've been at the Malaysian National Institute of Health (NIH).	Contextual information
2	Please tell us about the objectives of your sector/unit under the Malaysia NIH.	
3	Does your sector also participate in open science practice by publishing its research data after completing the research? If yes, [how]? If not, why?	RQ1: Data sharing practices
4	What are the benefits of open science practice through data sharing in your research sector/unit?	RQ2: Perceived benefits of data sharing
5	What challenges (major and minor) are faced mainly by you and your unit under the NIH while practising open science through research data sharing?	RQ3: Challenges in implementing data sharing
6	How do you think the ministry and the NIH management can further support and promote open science practice at the institution and in Malaysia?	RQ4: Proposed strategies to promote data sharing

Data analysis

All interviews were audio-recorded and transcribed verbatim. Thematic analysis was conducted using Atlas.ti software to identify recurring patterns and themes. The analysis

followed Braun and Clarke's (2006) six-phase framework: familiarisation with the data, generating codes, identifying and reviewing themes, defining and naming themes, and reporting findings. The analysis was inductive, grounded in participants' experiences rather than a predetermined framework, and themes were aligned with the study's research objectives to ensure analytical clarity and relevance. The datasets supporting the findings of this study are publicly accessible via the NIH Data Repository System (NIH-DaRS) at the following link: https://nihdars.nih.gov.my/search/by?keyword=open+science.

RESULTS

Demographic information of participants

The sample comprises seven participants, coded as Ps_1 to Ps_7, representing various research institutes and divisions at the Malaysian NIH. Prior to the interview sessions, one or two management staff members from each of the six institutions and two divisions under the Malaysian NIH were scheduled to be interviewed. The heads of departments and units were proposed as interviewees, and seven successful interviews were conducted with representatives from each research institute and division. However, no sessions were held in two departments (the Office of the NIH Registrar and the Health Behavioural Research Institute) due to unforeseen circumstances, such as participant absences and other work constraints. Nevertheless, data saturation was achieved. According to Table 2, the participants held diverse positions within the NIH. Their experience at the NIH ranged from less than two years to over ten years. This diversity provides perspectives from both newer and more established members of the NIH. The participants also represented various research institutes and divisions within the NIH, ensuring a broad perspective on open science practices across different research areas.

Table 2: Participants demographic information

S/N	Codes	Research institute and division	Position	Years at NIH
1	Ps_1	Institute of Public Health	Med. specialist	Less than 2 years
2	Ps_2	Institute of Health Management	Research officer	Less than 2 years
3	Ps_3	Health Systems Research Institute	Research officer	More than 10 years
4	Ps_4	Office of the NIH Manager	Head of unit	More than 10 years
5	Ps_5	Office of the NIH Manager	Med. officer	Between 5 and 10 years
5	Ps_6	Clinical Research Institute	Head of unit	Between 5 and 10 years
6	Ps_7	Medical Research Institute	Head of unit	More than 10 years

Data sharing practices in Malaysian NIH

The data revealed a complex and evolving landscape of data-sharing practices at the Malaysian National Institutes of Health (NIH). While institutional structures to support open science are gradually emerging, actual participation in open data sharing remains inconsistent across different units. Thematic analysis identified two interrelated themes: (i) fragmented and inconsistent engagement, and (ii) reliance on internal systems with limited openness.

i) Fragmented and inconsistent engagement

Most participants acknowledged that, although there is some awareness of open science principles, actual data sharing beyond traditional publication remains limited. For many units, open data practices are not yet institutionalised or widely adopted. As one participant noted:

"…to the best of my knowledge, currently we publish in open access journals, but at the moment we do not freely publish our research data." (Ps_1)

This view was echoed by others, who described data sharing as occurring only within the context of publication, without extended reuse or public accessibility:

"Okay, I think now we do not directly share our data yet. We have not practised open science extensively. Maybe we just share our data during publication." (Ps_3)

Another participant highlighted the limited cultural uptake of data sharing, indicating that even though NIH has an internal repository, open data practices remain outside the norm:

"Okay, I think you have discussed with Dr xxx, it is not really the traditional way of doing things here in Malaysia, at least in the Ministry of Health. But we do publish some of our research data to the data repository within NIH." (Ps_5)

ii) Reliance on internal systems with limited openness

While full public data sharing is not yet routine, several institutional mechanisms support internal research documentation and restricted use of repositories. These include the NIH's internal Research Management System (RMS) and support for data curation. One participant described the infrastructure:

"…yes, of course. As you know, at NIH we have a system called the Research Management System, where all researchers at NIH enter all information about their research activities. For example, if we publish an article in a journal, we will enter the article information into the Research Management System, as well as our other activities." (Ps_7).

Support services are also available through NIH for data analysis and curation, which form part of the preparatory infrastructure for open science:

"…there are a few strategies that we have implemented to ensure that they embrace open science and data sharing, particularly for the data repository. The second is the curation of research data produced by NIH researchers and the Ministry of Health under the data repository." (Ps_4).

However, a significant barrier to data openness is the approval process required from the Ministry of Health's top leadership. Participants noted that any form of data release, particularly for public access, must be vetted and approved by the Director General:

"…in the MoH, anything we want to publish, or share depends on the approval of the Director General of the Ministry of Health…" (Ps_2).

These findings suggest that while foundational systems and partial practices exist, there is a pressing need for clearer data governance structures, stronger institutional mandates, and a shift in organisational culture towards sustained and transparent data-sharing norms.

Perceived benefits of data sharing among researchers in the Malaysian NIH

Participants identified various benefits associated with open science practices through data sharing, from both institutional and researcher perspectives. Four main themes emerged from the interviews: i) enhanced research; ii) improved recognition; iii)

transparency and accountability; and iv) resource optimisation. These themes illustrate both the aspirational and practical value of data sharing within the Malaysian NIH, as shown in Figure 3.

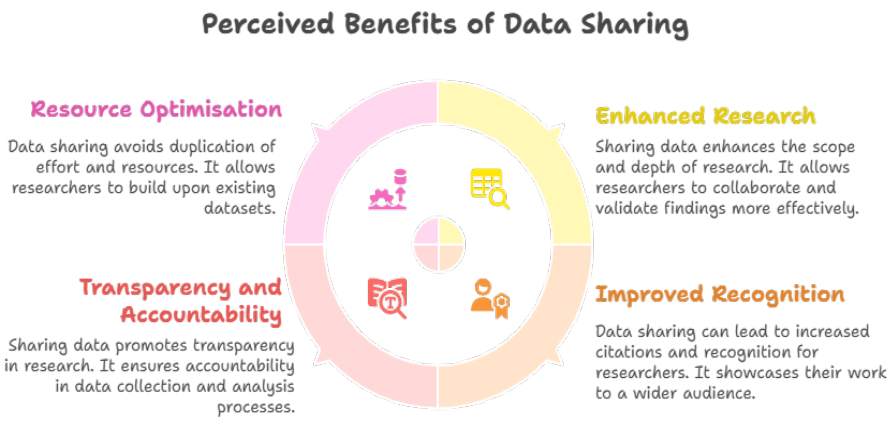

Figure 3. Perceived benefits of data sharing among researchers in Malaysia NIH

i) Enhanced research

One of the most noticeable themes that emerged from participants' responses was the potential for open data sharing to enhance the scope, depth, and innovation of research. Participants indicated that shared data could lead to integrative analyses, expand project dimensions, and promote new insights through diverse interpretations of the same dataset.

"…and another thing, through open source, a researcher can expand the existing scope of a particular research project. For example, if initially a researcher has data from a study on patient death and the reasons for morbidity or mortality, then another researcher who has other data, for example, on diabetes, and linking data on morbidity and death, can contribute further." (Ps_7).

"…and then two other people will have different perspectives on how they perceive our data. That, I think, is the most important aspect when it comes to open science. To be able to have different perspectives from one set of data is something that will enrich science in the long run." (Ps_5).

The expansion of research through shared datasets was also linked to increased collaboration and innovation:

"Okay, so the benefits of sharing the data are that they can have an increased number of citations, increased visibility, and also allow for expansion of innovation and escalate collaboration." (Ps_6).

"…So those are the things that can help them to enhance open science within their research areas and find the right people who have the same interests. That will help to build their network as well." (Ps_4).

ii) Improved recognition

Open data practices were also seen as enhancing researchers' professional recognition. Participants highlighted the opportunity to be notified when others use their data, opening pathways for collaboration and increased academic visibility:

"…whenever a researcher or other researchers request data from research that they have put in, they will receive notification. So that will give them that advantage or rather incentive for them or motivation for them to put more data in for them to share their data from that notification, they can contact other researchers who are going to use those data for them to collaborate if they want to." (Ps_4).

"…Okay, so the benefits of sharing the data are that they can have increased number of citations, increased visibility, and also allows for expansion of innovation and escalates collaboration." (Ps_6).

There was also recognition that integrating data sharing requirements into national grant applications, such as through the NMRR, could institutionalise these practices and incentivise use of platforms like NIH-DaRS:

"…in the future, perhaps what we were thinking of is that whenever they want to receive grant or whenever they want to put their proposal in under the NMRR, under MOH, probably, we need to put a data management plan whereby they need to put what is their plan in terms of the data repository and so on. So that will again enhance their embracement of open science, particularly using NIH DaRS." (Ps_4).

iii) Transparency and accountability

Participants described data sharing to enhance scientific integrity, enabling others to validate results and ensuring accountability. Transparency was associated with building trust and fostering continuous improvement in the research process:

"…I think actually, it is good to share the data because it is more transparent…" (Ps_2).

"…Correct. One is transparency in terms of the research process and all. Well, we are human beings. Definitely, we are not immune from making errors and all." (Ps_5).

For some, there was also a sense of intrinsic satisfaction and professional pride in contributing to a broader culture of openness:

"…I think somewhat some kind of satisfaction because we know how valuable the data is, because we also use data from other agencies…" (Ps_3).

iv) Resource optimisation

Several participants linked data sharing to improved resource efficiency within and across government ministries. Open access to existing datasets could reduce redundant studies, minimise unnecessary spending, and streamline access to critical information:

"…and also, maybe can escalate collaboration between other ministries and then maybe can also reduce the duplication of research… some ministries already has that research and why do we need to duplicate it because we do not share our research output, so we do not know that the ministry has already done the research…." (Ps_2).

"…the data sharing first, it will reduce the time needed to assess the data. Because the data is openly available." (Ps_1).

"And also, can increase access to publications and journals, and also it can reduce the duplication of research and the cost of creating and reusing data…." (Ps_6).

Taken together, these findings underscore the multi-level value proposition of open science. From enabling more sophisticated scientific inquiry to fostering inter-agency collaboration, data sharing holds promise as both a technical and strategic tool for advancing research excellence at the Malaysian NIH.

Challenges in implementing data sharing in Malaysia NIH

While participants acknowledged the potential value of open science, they highlighted numerous challenges impeding effective data sharing practices within the Malaysian NIH. These challenges were categorised into six key themes: i) data management and policy; ii) knowledge and training needs; iii) performance measurement; iv) exposure of research flaws: v) resource constraints, and vi) privacy considerations as shown in Figure 4.

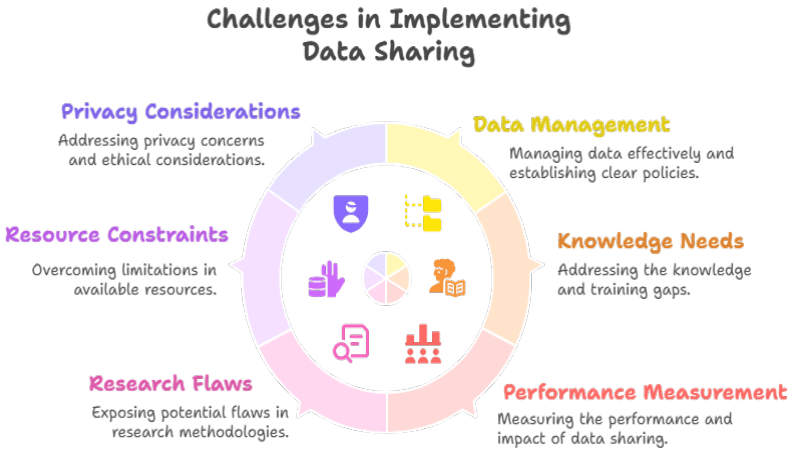

Figure 4: Challenges in implementing data sharing

i) Data management and policy

A prominent barrier cited by participants was the absence of coherent and standardised data management practices across NIH units. Many researchers lacked clear data management plans or data dictionaries, which hindered their ability to share datasets meaningfully. In some cases, data loss or corruption also prevented sharing. Unclear data ownership, stakeholder concerns, and a lack of harmonised institutional policies compounded these challenges.

"Yes, I think the main issue is data management, because we need to properly keep, organise, and maintain the data, especially data involving confidential information and respondents' personal data." (Ps_2).

"One of the reasons is that their data management needs improvement… they do not have a proper data dictionary… especially when they have left those research projects a few years ago." (Ps_4).

Beyond technical concerns, participants also highlighted the importance of clear and accessible policies governing data sharing, including defined embargo periods and compliance with privacy laws:

"I think the main challenge, as I said, is the regulations and the Data Protection Act… the guidelines should be openly available… so that researchers like us are more willing to share data." (Ps_1).

"Data management can be divided into security and organisation… and then there is the prohibition from stakeholders; both are challenges we face." (Ps_2).

"There are no clear policies, and I do not see any push factor coming from MOH, Malaysia, requiring you to make your data open." (Ps_5).

ii) Knowledge and training needs

Participants consistently identified insufficient knowledge and training as major barriers to data sharing. Many researchers, including those in leadership roles, had limited exposure to open science concepts and lacked the skills to prepare and share data effectively, as indicated by the following verbatim statement:

"We did it as a roadshow (to create awareness), but after this we want to provide training on open science, and perhaps it is a data stewardship (training) for all NIH researchers." (Ps_6)

iii) Performance measurement

The current research performance evaluation system was also seen as misaligned with the values of open science. Researchers were reluctant to share data because institutional metrics prioritise publications over data availability, as stated below:

"*When a researcher or academician… their performance is just based on… number of publications… people will want to hold the data set and be less likely to share openly…"* (Ps_1).

"Okay, so one is traditional metrics to evaluate your performance… does not consider publishing data as part of the metrics that they evaluate." (Ps_5).

iv) Exposure of research flaws

Participants also raised concerns about potential exposure to scrutiny and methodological flaws through data sharing. Fear of criticism or reputational risk may discourage researchers from engaging in open science practices:

"…maybe we are afraid if there is some flaw in the methodology of the data… because it can affect our publication." (Ps_3).

v) Resource constraints

Financial constraints were identified as a practical barrier to data sharing. Some platforms charge fees for data deposition, and uncertainty about who will bear the cost may deter researchers from participating.

"Some publications or submissions of data online… require a cost… who is going to pay for the submission? If researchers have to pay to preserve the data… it will make it even less likely for them to be willing to submit." (Ps_1).

vi) Privacy considerations

Participants expressed concern about the sensitivity of certain health-related datasets and the associated legal obligations. Clearer guidelines and standard operating procedures were seen as necessary to balance openness with confidentiality.

"Maybe because it contains some sensitive information… only for Minister of Health… bureaucracy… we government officers, we have to sign the agreement on privacy… So maybe we need a clear cut of things that we can share…" (Ps_3)

These findings reveal that promoting open science within the Malaysian NIH requires not only technical infrastructure and policies but also a significant cultural and systemic shift. Addressing these barriers comprehensively will be critical to enabling sustainable and meaningful data sharing practices across the institution.

Proposed strategies to promote data sharing in the Malaysian NIH

To identify ways to improve data sharing practices under open science at the Malaysian NIH, participants were asked to suggest strategies that the Ministry of Health and NIH leadership could implement to enhance data sharing. Their responses were categorised into six thematic areas: i) increasing awareness and capacity building; ii) data management support; iii) policy and guidelines; iv) financial support; v) performance measures; and vi) technical improvements, as shown in Figure 5.

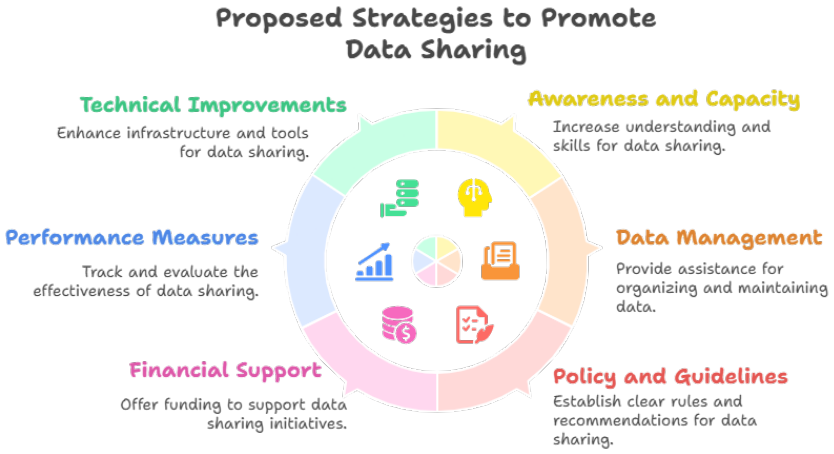

Figure 5: Proposed strategies to promote data sharing

i) Increasing awareness and capacity building

Participants consistently emphasised the importance of fostering a culture of data sharing through awareness campaigns, training workshops, and promoting successful use cases. These strategies aim to normalise open science practices and encourage researcher engagement across MoH institutions.

"…awareness of what open science is, its benefits and prospects is still low among researchers…" (Ps_7)

" to create that awareness so people on the ground realise that the data they enter is also valuable for them…" (Ps_4)

ii) Data management support

Improving data management practices emerged as a critical enabler for open science. Participants recommended establishing embargo periods, appointing data custodians across MoH divisions, and allocating dedicated staff to support data curation and platform maintenance.

"Unless they want to push for open access, they should set an embargo period. After that period, the data should be sent to NIH-DaRS." (Ps_1)

"Management can provide a dedicated human resource to manage and maintain the platform." (Ps_3)

"We need to identify the right data custodian for each of these units in MoH, understand what data is available, and how we can actually extract those data." (Ps_4)

iii) Policy and guidelines

Participants called for clearer, more accessible policies to guide data sharing efforts. They highlighted the need for transparency in procedures, stakeholder buy-in, and possibly a centralised governing body to oversee implementation.

"The guidelines should be openly available, very clear, and the process should be transparent so that people, researchers like us, are more willing to share data." (Ps_1).

"This needs to be handled or governed by an entity to ensure that these processes can be streamlined." (Ps_4).

"Researchers should be mandated to share their data with one or two systems, without fear of repercussion." (Ps_5).

iv) Financial support

Cost-related concerns were also raised. Participants suggested that funding models or institutional support mechanisms should be explored to offset the financial burden of data publication.

"The question now is, if I were to submit that, would the management pay for it? That is also something you need to take into consideration." (Ps_1).

v) Performance measures

Participants emphasised the need to align performance evaluation systems with open science objectives. They recommended introducing metrics that reward data sharing to motivate researchers to adopt open practices.

"The key performance indicator (KPI) should not be linked to publications… if you share your data, then it should also give you an extra point…" (Ps_1).

"…Maybe they can include it as a KPI or something… maybe they could assign the highest score for that" (Ps_3).

vi) Technical improvements

Several participants emphasised the importance of enhancing the technical infrastructure that supports data sharing. Suggestions included adopting cloud computing technologies, improving repository features, and incorporating DOIs for proper citation and reuse.

"…You need to have the right infrastructure as well… probably using cloud computing… linking one data set to another in a secure manner." (Ps_4).

"We are planning to get all the DOIs and all other elements of open science into the system." (Ps_5).

The findings highlight that a multifaceted approach, encompassing policy reform, infrastructure investment, institutional incentives, and targeted awareness efforts, is essential to advancing open science practices at the Malaysian NIH.

DISCUSSIONS

Although the Malaysian NIH has taken steps to institutionalise open science through platforms such as NIH-DaRS, data sharing remains uneven. Many researchers still restrict sharing to open-access publications and hesitate to deposit raw data in institutional repositories. This limited engagement is consistent with earlier findings by Hodonu-Wusu, Noorhidawati, and Abrizah (2020) and Ahmed and Othman (2021b), who noted only moderate awareness and minimal repository use among Malaysian researchers. The study found a mixed level of participation, while some researchers use internal mechanisms such as the NIH Research Management System, widespread data sharing is hindered by bureaucratic approval processes, particularly the requirement for clearance from the Director General of Health before external dissemination. This centralised governance approach prioritises control and caution, limiting openness and researcher autonomy.

These challenges reflect trends observed internationally. Hall et al. (2024) reported similarly low engagement with data-sharing platforms in leading US research institutions, despite significant investment in infrastructure. Likewise, Zhu (2020) identified technical, psychological, and institutional barriers to data sharing in the UK, noting that researchers often value data sharing in principle but rarely practise it. Overall, these findings underscore that promoting open science requires more than technical infrastructure. It demands systemic governance reform, strong institutional leadership, and active researcher engagement to address the deep-rooted cultural and operational barriers that constrain data-sharing adoption.

Perceived benefits of data sharing

Participants identified several benefits of data sharing within the open science framework, including enhanced research quality, interdisciplinary collaboration, increased transparency, and more efficient use of resources. These findings are consistent with literature describing open science as a catalyst for research visibility, credibility, and recognition (Allen & Mehler, 2019; Curioni & Gil, 2024). A key benefit noted by NIH researchers was improved research outcomes through collaborative data use. Sharing datasets enables peers to analyse information from different perspectives, fostering innovation and expanding research scope, echoing Arza and Fressoli (2017), who emphasise that open science reduces redundancy and accelerates cumulative knowledge building.

Participants also recognised that data sharing strengthens transparency and reproducibility, enhancing trust within the scientific community and the public. As Allen and Mehler (2019) argue, open practices such as data sharing and pre-registration promote research rigour and enable validation through replication. Recognition and academic credit were additional motivators. Researchers noted that open datasets could increase citations, collaborations, and professional visibility. These findings are also supported by Devriendt, Borry, and Shabani (2021) and Dorta-González et al. (2021), who highlight data citations as a new form of scholarly recognition. Another key benefit was resource optimisation. Open data reduces duplication of studies across agencies, improving time and cost efficiency (M'kulama & Akakandelwa, 2021; Rafiq & Ameen, 2022). Overall, these benefits align with Malaysia's Open Science Platform (MOSP) vision, which seeks to enhance collaboration, minimise redundancy, and maximise research impact (Akademi Sains Malaysia, 2019). The alignment with international FAIR principles (Wilkinson et al., 2016) further highlights the role of data sharing in building a transparent, efficient, and globally connected research ecosystem.

Institutional and operational challenges

This study identified several institutional and operational barriers that limit effective data sharing and the adoption of open science at the Malaysian NIH. These challenges span technical, ethical, organisational, and cultural dimensions. A major institutional issue is weak data management, characterised by the absence of data dictionaries, inconsistent metadata, and fragmented policies. These findings are consistent with Ariffin and Abd Aziz (2022), who noted limited readiness among Malaysian public servants to produce quality open data. Similarly, unclear data ownership and inconsistent governance reflect the concerns of Nicholas et al. (2020) and Zabijakin-Chatleska and Cekikj (2020), who observed that the lack of clear mandates discourages researchers from sharing data.

Legal and ethical concerns are particularly critical in health and biomedical research, where data sensitivity and privacy are paramount. As Byrd et al. (2020) emphasised, responsible data sharing requires ethical frameworks that balance transparency and confidentiality. At the NIH, sharing often depends on senior approval and stakeholder restrictions, reinforcing a culture of caution rather than openness. Infrastructure limitations also constrain participation. Participants cited inadequate integrated systems and insufficient technical support for data storage and curation, issues mirrored in Banks et al. (2019), who highlighted the financial and logistical burdens of open science adoption.

Furthermore, many researchers lack awareness and training in research data management and open science principles. This skills gap hinders engagement, which consistent with Melero and Navarro-Molina (2020) and Aleixandre-Benavent et al. (2020), who advocate targeted capacity-building and institutional awareness programmes. Another critical issue is the misalignment between open science and performance evaluation. Research output at the NIH is primarily judged by publications, with little recognition for data sharing. As Devriendt, Borry, and Shabani (2021) argue, this lack of formal incentives discourages data preparation and reuse. Minor but influential factors also emerged, including fear of exposing methodological flaws, reputational risk, and costs associated with repository submission (Nicholas et al., 2020; Besançon et al., 2021). Privacy concerns surrounding sensitive datasets further underscore the need for clear anonymisation guidelines and embargo policies (Erb et al., 2021). In summary, overcoming these challenges requires policy reform, technical upgrades, and cultural change. Strengthening governance, investing in infrastructure, and aligning incentives with open science objectives will be vital for cultivating a sustainable data-sharing culture within the Malaysian NIH.

Proposed strategies for advancing open science

The study indicates that advancing open science at the Malaysian NIH requires a comprehensive, multi-dimensional strategy. Participants proposed key initiatives, including enhancing researcher awareness, implementing capacity-building programmes, providing performance-based incentives, strengthening data governance, and improving technical infrastructure. These align with previous research calling for systemic reform to embed open science into institutional practices (Ahmed et al., 2024; Ahmed & Othman, 2021a). A central recommendation was the need for strong and sustained leadership from the Ministry of Health. Participants stressed that open science cannot succeed without executive-level endorsement and policy commitment, supporting Pujades Corbi (2023), who highlights leadership as a key driver of open science adoption in health institutions. Additional measures include standardised embargo policies, establishing data curator roles, and integrating data sharing into performance evaluations, echoing suggestions by Devriendt, Borry, and Shabani (2021) and Ariffin and Abd Aziz (2022) for blending technical and human resource interventions. Participants also emphasised the value of showcasing success stories to demonstrate the tangible benefits of open science, particularly through platforms such as NIH-DaRS. Increased visibility can foster trust, participation, and a culture of openness across the institution. Overall, these strategies reflect a shift from isolated technical efforts to a holistic ecosystem approach, driven by awareness, incentives, and institutional stewardship – key ingredients for embedding open science as a sustainable organisational practice.

CONCLUSIONS

This study examined the implementation of open science practices, focusing on research data sharing at the Malaysian NIH. Findings indicate that while researchers recognise the benefits of open science, such as improved collaboration, transparency, recognition, and efficiency, numerous barriers continue to limit participation. These include weak data management systems, unclear institutional policies, limited awareness and training, dependency on stakeholder approval, and performance metrics that prioritise publications over data sharing. Participants proposed several strategies to overcome these challenges, emphasising leadership commitment, clear policy frameworks, capacity-building programmes, and enhanced technical and financial support. The findings reaffirm that promoting open science is not merely a technical reform but a cultural and organisational transformation requiring sustained institutional commitment.

A major strength of this study is its qualitative depth, capturing the perspectives of NIH administrative and managerial staff involved in research governance. However, limitations include a relatively small sample and the exclusion of frontline researchers, which may have constrained the diversity of views. Future research should incorporate a broader participant base, including early-career and field researchers, and apply mixed-method approaches to strengthen the generalisability of results. Comparative studies across other national research bodies could further contextualise open science implementation in Malaysia. In sum, the Malaysian NIH stands at a critical turning point in its open science journey. While initiatives such as NIH-DaRS demonstrate institutional readiness, translating these efforts into active researcher engagement will require coordinated policy, leadership, and infrastructure support. With sustained effort, the NIH can serve as a national model for integrating open science within Malaysia's public health research ecosystem.

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CONFLICT OF INTEREST

The authors have no relevant competing interests to declare regarding the content of this article.

AUTHOR CONTRIBUTIONS

Conceptualization: [Ahmed, M., Othman, R. and Ismail, Hafiz Ismail, M.Z.]; Methodology: [all authors]; Formal analysis and investigation: [Ahmed, M.]; Writing - original draft preparation: [Ahmed, M.]; Writing - review and editing: [all authors]

REFERENCES

Ahmed, M., & Othman, R. (2021a). Promoting open science with institutional repositories in the Malaysian comprehensive public universities. *Journal of Information Systems and Digital Technologies, 3*(2), 11–28. https://doi.org/10.31436/jisdt.v3i2.209.

Ahmed, M., & Othman, R. (2021b). Readiness towards the implementation of open science initiatives in the Malaysian Comprehensive Public Universities. *The Journal of Academic Librarianship, 47*(5), 102368. https://doi.org/10.1016/j.acalib.2021.102368.

Ahmed, M., Othman, R., Noordin, M. F., Ibrahim, A. A., & Al-Hussaini, A. I. S. (2025). Factors influencing open science participation through research data sharing and reuse among researchers: A systematic literature review. *Knowledge and Information Systems, 67*(3), 2801-2853. https://doi.org/10.1007/s10115-024-02284-3.

Ahmed, M., Othman, R., Noordin, M. F., Ismail, M. Z. H., Abd Karim, Z., & Syed Anera, S. N. (2024). Understanding factors influencing the adoption of open science practices among Malaysia's NIH researchers. *Information Development*. https://doi.org/10.1177/02666669241248145.

Akademi Sains Malaysia. (2019). *iConnect & MOSP*. https://www.akademisains.gov.my/ar19/i-connect-mosp/.

Aleixandre-Benavent, R., Vidal-Infer, A., Alonso-Arroyo, A., Peset, F., & Sapena, A. F. (2020). Research data sharing in Spain: Exploring determinants, practices, and perceptions. *Data, 5*(2), Article 29. https://doi.org/10.3390/data5020029.

Allen, C., & Mehler, D. M. A. (2019). Open science challenges, benefits and tips in early career and beyond. *PLoS Biology, 17*(5), e3000246. https://doi.org/10.1371/journal.pbio.3000246.

Ariffin, A. S., & Abd Aziz, M. A. S. (2022). Public servants' perception towards publishing quality and impactful open data to support open science initiatives in Malaysia. *Journal of Science, Technology and Innovation Policy, 8*(1), 44–57. https://doi.org/10.11113/jostip.v8n1.111.

Arza, V., & Fressoli, M. (2017). Systematizing benefits of open science practices. *Information Services and Use, 37*(4), 463–474. https://doi.org/10.3233/isu-170861.

Banks, G. C., Field, J. G., Oswald, F. L., O'Boyle, E. H., Landis, R. S., Rupp, D. E., & Rogelberg, S. G. (2019). Answers to 18 questions about open science practices. *Journal of Business and Psychology, 34*(3), 257–270. https://doi.org/10.1007/s10869-018-9547-8.

Besançon, L., Peiffer-Smadja, N., Segalas, C., Jiang, H.-T., Masuzzo, P., Smout, C., Billy, E., Deforet, M., & Leyrat, C. (2021). Open science saves lives: Lessons from the COVID-19 pandemic. *BMC Medical Research Methodology, 21*(1), 117. https://doi.org/10.1186/s12874-021-01304-y.

Bordelon, D., & Starry, R. (2025, February 27). *Course & subject guides: Data Management @ Pitt*. University of Pittsburgh Library System. https://pitt.libguides.com/managedata.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa.

Byrd, J. B., Greene, A. C., Prasad, D. V., Jiang, X.-Q., & Greene, C. S. (2020). Responsible, practical genomic data sharing that accelerates research. *Nature Reviews Genetics, 21*(10), 615–629. https://doi.org/10.1038/s41576-020-0257-5.

Cathy, F. (2021, December 6). *How the United Nations' new "open science framework" could speed up the pace of discovery*. Phys.org. https://phys.org/news/2021-12-nations-science-framework-pace-discovery.html.

Chen, H., Zhao, Y.-Y., Cao, B.-W., Petersen, D. J., Valente, M. J., & Cen, W.-L. (2024). Breaking the silence of sharing data in medical research. *PloS One, 19*(5), e0301917. https://doi.org/10.1371/journal.pone.0301917.

Cook, B. G., Fleming, J. I., Hart, S. A., Lane, K. L., Therrien, W. J., van Dijk, W., & Wilson, S. E. (2022). A how-to guide for open-science practices in special education research. *Remedial and Special Education, 43*(4), 270–280. https://doi.org/10.1177/07419325211019100.

Curioni, A., & Gil, D. (2024). Chapter 6: Open science as a catalyst for resilience in society. In A. M. Cauce, Y. Flückiger, & I. Popović (eds.), *The new road to success: Contributions of universities towards more resilient societies* (Vol. 14, pp. 67-78). The Association Glion Colloquium. https://glion.org/wp-content/uploads/2024/03/The-New-Road-to-Success_Cauce-Fluckiger-Popovic_2024_compressed.pdf.

Devriendt, T., Borry, P., & Shabani, M. (2021). Factors that influence data sharing through data sharing platforms: A qualitative study on the views and experiences of cohort holders and platform developers. *PLoS ONE, 16*(7), e0254202. https://doi.org/10.1371/journal.pone.0254202.

Dezhina, I. G. (2023). Advantages and challenges to open science practices. *Terra Economicus, 21*(3), 70-87. https://doi.org/10.18522/2073-6606-2023-21-3-70-87

Dorta-González, P., González-Betancor, S. M., & Dorta-González, M. I. (2021). To what extent is researchers' data-sharing motivated by formal mechanisms of recognition and credit? *Scientometrics, 126*(3), 2209–2225. https://doi.org/10.1007/s11192-021-03869-3.

Erb, B., Bösch, C., Herbert, C., Kargl, F., & Montag, C. (2021). *Emerging privacy issues in times of open science.* OSF Preprints. https://osf.io.

Hak, F., Abelha, A., & Santos, M. (2020). Open science in pandemic times: A literature review. *Procedia Computer Science, 177*, 552–555. https://doi.org/10.1016/j.procs.2020.10.077.

Hall, E. S., Melton, G. B., Payne, P. R. O., Dorr, D. A., & Vawdrey, D. K. (2024). How are leading research institutions engaging with data sharing tools and programs? *AMIA Annual Symposium Proceedings, 2023*, 397-406.

Hodonu-Wusu, J. O., Noorhidawati, A., & Abrizah, A. (2020). Malaysian researchers on open data: The first national survey on awareness, practices and attitudes. *Malaysian Journal of Library and Information Science, 25*(2), 1–20. https://doi.org/10.22452/mjlis.vol25no2.1.

M'kulama, A. C., & Akakandelwa, A. (2021). Research data sharing and reuse through open data: Assessing researcher awareness and perceptions at the Zambia Agricultural Research Institute (ZARI). In P. Jain, N. Mnjama, & O. Oladokun (eds.), *Open access implications for sustainable social, political, and economic development* (pp. 284–306). IGI Global Scientific Publishing. https://doi.org/10.4018/978-1-7998-5018-2.ch015.

Mahony, S. (2022). Toward openness and transparency to better facilitate knowledge creation. *Journal of the Association for Information Science and Technology, 73*(10), 1474-1488. https://doi.org/10.1002/asi.24652.

Marshall, M. N. (1996). Sampling for qualitative research. *Family Practice, 13*(6), 522–526. https://doi.org/10.1093/fampra/13.6.522.

Melero, R., & Navarro-Molina, C. (2020). Researchers' attitudes and perceptions towards data sharing and data reuse in the field of food science and technology. *Learned Publishing, 33*(2), 163–179. https://doi.org/10.1002/leap.1287.

National Institutes of Health (NIH). (2025, September 3). *National Institutes of Health: Corporate info*. National Institutes of Health, Ministry of Health Malaysia. https://www.nih.gov.my/about-nih/corporate-info.

Nicholas, D., Jamali, H. R., Herman, E., Watkinson, A., Abrizah, A., Rodríguez-Bravo, B., Boukacem-Zeghmouri, C., Xu, J., Świgoń, M., & Polezhaeva, T. (2020). A global questionnaire survey of the scholarly communication attitudes and behaviours of early career researchers. *Learned Publishing, 33*(3), 198–211. https://doi.org/10.1002/leap.1286.

Parker, M., & Bull, S. (2015). Sharing public health research data: Toward the development of ethical data-sharing practice in low- and middle-income settings. *Journal of Empirical Research on Human Research Ethics, 10*(3), 217–224. https://doi.org/10.1177/1556264615593494.

Pujades Corbi, C. (2023). Some thoughts about open science: A few challenges and a great opportunity for science. *Hipertext.net, 27*, 107-111. https://doi.org/10.31009/hipertext.net.2023.i27.11.

Rafiq, M., & Ameen, K. (2022). Research data management and sharing awareness, attitude, and behavior of academic researchers. *Information Development, 38*(3), 391–405. https://doi.org/10.1177/02666669211048491.

Read, K. B., Ganshorn, H., Rutley, S., & Scott, D. R. (2021). Data-sharing practices in publications funded by the Canadian Institutes of Health Research: A descriptive analysis. *CMAJ Open, 9*(4), E980–E987. https://doi.org/10.9778/cmajo.20200303.

Saeed, S., & Naushad Ali, P. M. (2019). Research data management and data sharing among research scholars of life sciences and social sciences. *DESIDOC Journal of Library & Information Technology, 39*(6), 290–299. https://doi.org/10.14429/djlit.39.06.14997.

Suhr, B., Dungl, J., & Stocker, A. (2020). Search, reuse and sharing of research data in materials science and engineering—A qualitative interview study. *PLoS ONE, 15*(9), e0239216. https://doi.org/10.1371/journal.pone.0239216.

Tan, A. C., Webster, A. C., Libesman, S., Yang, Z.-J., Chand, R. R., Liu, W., Palacios, T., Hunter, K. E., & Seidler, A. L. (2024). Data sharing policies across health research globally: Cross-sectional meta-research study. *Research Synthesis Methods, 15*(6), 1060–1071. https://doi.org/10.1002/jrsm.1757.

Ünal, Y., Chowdhury, G., Kurbanoğlu, S., Boustany, J., & Walton, G. (2019). Research data management and data sharing behaviour of university researchers. *Information Research: An International Electronic Journal, 24*(1), Paper ISIC 1818. https://www.informationr.net/ir/24-1/isic2018/isic1818.html.

UNESCO. (2023, September 21). *UNESCO recommendation on open science*. https://www.unesco.org/en/open-science/about.

Wibowo, M. P., & Mon, L. (2025). Investigating the practices and preferences of health scholars in sharing open research data. *PloS One, 20*(2), e0313644. https://doi.org/10.1371/journal.pone.0313644.

Wilkinson, M. D., Dumontier, M., Aalbersberg, I. J., Appleton, G., Axton, M., Baak, A., Blomberg, N., Boiten, J.-W., da Silva Santos, L. B., Bourne, P. E., Bouwman, J., Brookes, A. J., Clark, T., Crosas, M., Dillo, I., Dumon, O., Edmunds, S., Evelo, C. T., Finkers, R., … Mons, B. (2016). The FAIR Guiding Principles for scientific data management and stewardship: Comment. *Scientific Data, 3*, 160018. https://doi.org/10.1038/sdata.2016.18.

Zabijakin-Chatleska, V., & Cekikj, A. (2020). Attitudes and practices of data sharing and data preservation among social science researchers in the Republic of North Macedonia. *Balkan Social Science Review, 15*, 251–275. https://doi.org/10.46763/bssr20150252zc.

Zhu, Y.-M. (2020). Open-access policy and data-sharing practice in UK academia. *Journal of Information Science, 46*(1), 41–52. https://doi.org/10.1177/0165551518823174.