ZonMw

Pilot study on stimulating transparent laboratory animal research

Better Science through More Transparency

ZonMw Pilot study commissioned by the Ministry of Education, Culture and Science

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1. Executive Summary

Introduction & aim: Biomedical science faces a profound challenge with the replication crisis, given the discovery of many erroneous studies in scientific literature, which has jeopardized the reliability of published research findings. In response, the scientific community has developed various methods and research practices that potentially enhance transparency and reproducibility of scientific studies. This is considered particularly important for research involving laboratory animals, as it can prevent unnecessary duplication and improve the quality of animal-based research. Following various debates in the Dutch House of Representatives, the Dutch Ministry of Education, Culture, and Science (OCW) assigned ZonMw to investigate the impact on the research practice of these methods and the potential for their implementation to improve uptake. Therefore, this study is aimed at investigating how these methods are perceived by researchers and other stakeholders, what hurdles exist in applying these methods, and what the feasibility is of their effective implementation. Based on these findings, we provide a set of recommendations to advise stakeholders on the future steps regarding these transparency methods.

Methodology: We investigated the implementation of ZonMw's six transparency methods in animal research, focusing on the Dutch research landscape. Through online questionnaires and semi-structured interviews, we asked researchers and stakeholders involved in biomedical research (i.e. data stewards, members of animal welfare bodies, journal editors, deans, and funders) about their experiences and perspectives regarding these transparency methods. Surveyed researchers answered questions about their past experiences, external and internal support they received, and suggestions for improvements. Stakeholder interviews focused on existing (or lack of) recommendations and requirements, their influence on researchers, external influences of others on their policies, their motivations, and how they see the future of the field.

Transparency-increasing methods and research practices: ZonMw has incorporated the following transparency methods in different grant schemes:

1. Preregistration
2. Data management plans and FAIR data
3. ARRIVE guidelines
4. Open access publishing
5. Systematic reviews

(1) Preregistration of animal studies: Responding researchers displayed a limited awareness of the application of preregistration, with varying perceptions of their impact on transparency and quality of research. While some advocate for preregistration for its clear value in enhancing transparency and justifying animal research to society, reservations exist regarding its suitability for fundamental research or early drug discovery studies. Barriers to implementation include concerns about increased bureaucracy and a lack of awareness. Yet, these could be addressed by providing more information and education, streamlined processes (e.g. export between work protocols and registration platforms), and incentives to promote uptake, such as rewards or more specific requirements (for large preclinical trials).

(2) Data Management Plans and FAIR data: FAIRification of data was relatively well-known among respondents, yet less than half had previously designed a Data Management Plan

(DMP). While making data reusable was perceived positively in terms of its potential to enhance transparency, reliability, impact, and quality of research, there was mixed sentiment regarding the necessity of DMPs. Resistance among researchers, particularly senior ones, often stemmed from concerns about data reuse, perceived lack of benefits, and a conservative attitude towards data sharing. Challenges in the application of DMPs and FAIRification included process complexity and aspects such as data formatting, meta-data standards, and data interoperability. Despite these challenges, participants were willing to make their data more FAIR with assistance, personalised guidance or other support. Researchers already seek help from data stewards and various tools and courses. However, we need further improvements in promoting and aligning support services across research organisations. Additionally, institutional structure, culture, and policies influence the implementation of data management practices. Therefore, efforts should promote evidence of the methods' benefits, facilitate processes, and create additional recognition and rewards to enhance uptake. In parallel, creating value for the role of data stewards, including providing proper onboarding, support and means, and ensuring alignment of requirements across stakeholders are essential for successfully implementing DMPs and FAIR/data sharing practices across research organisations.

(3) ARRIVE guidelines: Respondents recognised the guidelines' importance and found them beneficial, yet their practical implementation faces challenges. Journal space limitations and lack of training and awareness seem to hinder adoption. Monitoring and enforcement are also difficult due to resource constraints and absence of effective verification methods for funders and journal editors. Solutions such as streamlining funders/journals monitoring with existing (AI) tools, increasing awareness and training via universities/animal welfare bodies, and simplifying application processes by focusing on the ARRIVE “Essential 10” should be explored to enhance implementation.

(4) Open Access Publishing: We found widespread awareness and adoption of open access publishing, mostly driven by funders' encouragement and requirements and university contracts to lower publication fees. However, financial barriers still hinder broader implementation, notably with concerns about the dominance of commercial publishers. Improvement could focus on discussing transitioning to community-driven publishing initiatives, increasing recognition for open access and data sharing, and improving monitoring. Addressing these challenges requires a cultural shift and careful consideration of power dynamics in the publishing ecosystem.

(5) Systematic reviews: Interviewees acknowledged the value of systematic reviews but deemed them impractical due to their time-consuming nature, high demand in terms of skills and cost, and bureaucratic hurdles. Alternative approaches consider demanding them in specific situations that would benefit the field or using a systematised approach to better justify chosen animal models/needs for animal models in ethical applications. Existing funding and support initiatives supporting systematic reviews are encouraged to be sustained.

Recommendations: Based on the conducted surveys and interviews, we propose the following twelve recommendations related to animal research in biomedical science:

1. **Preregistration:** Dutch funding organisations subsidising animal research should consider making preregistration of animal studies for large preclinical trials mandatory (i.e. trials preceding clinical trials).
2. **Preregistration and ARRIVE guidelines:** Dutch funders are advised to discuss with each other;1) what the type of reward (or sanction) to give for (lack of) compliance with preregistration or ARRIVE, 2) how and when to monitor preregistration in a similar fashion, 3) discuss which existing tools or information to use to monitor ARRIVE and 4) decide if they apply in requirement the "Essential 10" or the whole ARRIVE set. In each case, broad alignment between funders policies are recommended.
3. **Preregistration:** Universities, license holders and animal welfare bodies ought to promote preregistration to university courses (e.g. Article 9, science integrity, the curriculum in general) and the information provided to the researcher (e.g. add information to the instructions/protocols or website).
4. **DMPs & FAIR:** Funders could assess differences and similarities between the information they demand in terms of DMP and FAIR requirements for animal studies to avoid redundancy. Together with UNL & NFU, they could investigate the content of DMP templates used by research organisations to achieve greater alignment between what institutes and what funders ask and highlight needs for discipline-specific demands.
5. **Open Science:** Open science communities should discuss with their board of directors and deans on including the adherence to transparency methods to the evaluation and recognition of researchers.
6. **Data management:** Deans and the board of directors, in cooperation with their integrity centre or digital competence centres, should consider the possibility of adding an "entry protocol" around data management for PhDs and new employees.
7. **ARRIVE guidelines:** Animal welfare bodies may verify that research protocols comply with ARRIVE and see how to ensure aligning of content to allow automated method section generation.
8. **Publishing:** ZonMw/NWO and the Ministry of OCW may intensify the discussion on how the Dutch research landscape could transition out of the commercial publisher system, including the creation of a Dutch, academia-led publisher, supported by the government and large Dutch funders.
9. **FAIR, ARRIVE & Open Access:** Journal editors could stimulate within their journals more data-sharing policies, monitoring, and Open Sciences rewards (eg. Open Science badges).
10. **Systematic reviews:** ZonMw is encouraged to maintain its funding program within the MKMD program on the training in writing of systematic reviews; other health funders are advised to consider creating similar grant schemes.
11. **Systematic searching:** Animal Experimentation Committees (DECs), the Central Authority for Scientific Procedures on Animals (CCD) and Animal welfare bodies are encouraged to discuss how systematic searching can strengthen the ethical foundations of applications.
12. **Systematic reviews:** Universities could add training on systematic reviews to their available courses, in collaboration with existing experts and increase their pool of experts.

Conclusion: Although respondents consider the investigated transparency methods valuable tools to improve biomedical research in general and animal research in particular, their broad implementation depends on many factors. Lack of training, encouragement, support, resources, and awareness, next to competition and social pressure, prevent the full adoption of these methods. To promote their implementation, transparency methods should be integrated into the education and assessment, but also the recognition and rewards by funders, journals, and institutes. A large variety of stakeholders should be held accountable to provide necessary support and incentives and monitor standards to make the implementation sustainable. Notably, implementation will further increase regulatory pressure and administrative burden for researchers and may therefore not always be met with equal enthusiasm. Different stakeholders in the field should seek further alignment of procedures and policies. This may help to decrease this administrative burden and increase the harmonisation of requirements, but it may also increase the intrinsic motivation of scientists to start embracing these transparency methods as common practice. Till then, rewarding voluntary efforts may be more effective for implementation than imposing sanctions when mandatory methods are not (fully) met.

2. Management Samenvatting

Inleiding en doel: De biomedische wetenschap staat met de replicatiecrisis voor een grote uitdaging, gezien de ontdekking van veel foutieve studies in de wetenschappelijke literatuur, die de betrouwbaarheid van gepubliceerde onderzoeksresultaten in gevaar heeft gebracht. Als reactie hierop heeft de wetenschappelijke gemeenschap verschillende methoden en onderzoekspraktijken ontwikkeld, die de transparantie en reproduceerbaarheid van wetenschappelijke studies kunnen vergroten. Dit wordt zeker belangrijk gevonden voor onderzoek met proefdieren, omdat het onnodig dubbel werk kan voorkomen en de kwaliteit van dierproefonderzoek kan verbeteren. Naar aanleiding van recente debatten in de Tweede Kamer heeft het ministerie van Onderwijs, Cultuur en Wetenschap (OCW) ZonMw de opdracht gegeven om te onderzoeken wat de impact is van deze methoden op de onderzoekspraktijk en wat de inzet ervan kan zijn om de acceptatie te verbeteren. Daarom is deze studie gericht op het onderzoeken hoe deze methoden worden ervaren door onderzoekers en andere belanghebbenden, welke hindernissen er zijn bij het toepassen van deze methoden en wat de haalbaarheid is van de effectieve implementatie ervan. Op basis van deze bevindingen doen we een reeks aanbevelingen om belanghebbenden te adviseren over de toekomstige stappen met betrekking tot deze transparantiemethoden.

Methodologie: We onderzoeken de implementatie van de zes transparantiemethoden van ZonMw in dierproeven, gericht op het Nederlandse onderzoekslandschap. Door middel van online vragenlijsten en semi-gestructureerde interviews vroegen we onderzoekers en anderen die betrokken zijn bij biomedisch onderzoek (d.w.z. datastewards, leden van dierenwelzijns-instanties, tijdschriftredacteuren, decanen en financiers) naar hun ervaringen en perspectieven met betrekking tot deze transparantiemethoden. De ondervraagde onderzoekers beantwoordden vragen over hun ervaringen uit het verleden, externe en interne ondersteuning die ze kregen en suggesties voor verbeteringen. Interviews met belanghebbenden waren gericht op bestaande (of het gebrek aan) aanbevelingen en vereisten, hun invloed op onderzoekers, externe invloeden van anderen op hun beleid, hun motivaties en hoe zij de toekomst van het vakgebied zien.

Transparantieverhogende methoden en onderzoekspraktijken: ZonMw heeft de volgende transparantie methoden opgenomen in verschillende subsidieregelingen:

1. Pre-registratie
2. Datamanagement plannen en FAIR-data
3. ARRIVE richtlijnen
4. Open access publiceren
5. Systematische reviews

1. <u>Preregistratie van dierproeven:</u> Respondenten zijn zich weinig bewust van de mogelijkheden tot preregistratie, met uiteenlopende percepties van de impact ervan op de transparantie en kwaliteit van onderzoek. Hoewel sommigen pleiten voor preregistratie vanwege de waarde ervan voor het vergroten van de transparantie en het rechtvaardigen van dierproeven voor de samenleving, bestaan er bedenkingen bij de geschiktheid ervan voor fundamenteel onderzoek of vroege studies naar de ontdekking van geneesmiddelen. Belemmeringen voor de uitvoering zijn onder meer bezorgdheid over de toegenomen bureaucratie en onbekendheid met de methode, wat wijst op een behoefte aan voorlichting, gestroomlijnde processen (bv. export tussen werkprotocollen en registratieplatforms) en stimulansen om de

acceptatie te bevorderen, zoals beloningen of meer specifieke vereisten (voor grote preklinische proeven).

2. Dat management plannen en FAIR-data: FAIRificatie van data was relatief bekend bij de respondenten, maar minder dan de helft had eerder een Data Management Plan (DMP) ontworpen. Hoewel het herbruikbaar maken van data positief werd ervaren met betrekking tot de mogelijkheden om de transparantie, betrouwbaarheid, impact en kwaliteit van onderzoek te verbeteren, was er een gemengd sentiment over de noodzaak van DMP's. Weerstand onder onderzoekers, met name de meer gevestigde generatie, kwam vaak voort uit zorgen over hergebruik van gegevens, een ervaren gebrek aan voordelen en een conservatieve houding ten opzichte van het delen van gegevens. Uitdagingen bij de toepassing van DMP's en FAIRification waren onder meer procescomplexiteit en aspecten als dataformats, meta-datastandaarden en data-interoperabiliteit. Ondanks deze uitdagingen waren de deelnemers bereid om hun gegevens meer FAIR te maken met hulp, persoonlijke begeleiding of andere ondersteuning. Onderzoekers zoeken al hulp bij data stewards en verschillende tools en cursussen. Er zijn echter verdere verbeteringen nodig bij het bevorderen en op elkaar afstemmen van ondersteunende diensten in onderzoeks-organisaties. Bovendien beïnvloeden de institutionele structuur, cultuur en beleid de implementatie van gegevensbeheerpraktijken. Daarom moeten de inspanningen het bewijs van de voordelen van deze methoden bevorderen, processen vergemakkelijken en extra erkenning en beloningen creëren om de acceptatie te bevorderen. Tegelijkertijd is het creëren van waarde voor de rol van datasteward, inclusief het bieden van de juiste onboarding, ondersteuning en middelen, en het zorgen voor afstemming van de vereisten tussen belanghebbenden, essentieel voor het succesvol implementeren van DMP's en FAIR/data-uitwisselingspraktijken tussen onderzoeksorganisaties.

3. ARRIVE richtlijnen: Respondenten erkenden het belang van de ARRIVE richtlijnen en vonden ze nuttig, maar de praktische uitvoering ervan staat voor uitdagingen. Beperkingen in de ruimte in tijdschriften en gebrek aan training en bewustzijn lijken de acceptatie te belemmeren. Toezicht en handhaving zijn ook moeilijk vanwege de beperkte middelen en het ontbreken van effectieve verificatiemethoden voor financiers en tijdschriftredacteuren. Oplossingen zoals het stroomlijnen van de monitoring van financiers/tijdschriften met bestaande (AI-)tools, het vergroten van het bewustzijn en de opleiding via universiteiten of dierenwelzijnsinstanties, en het vereenvoudigen van aanvraagprocedures door zich te concentreren op de ARRIVE “Essential 10” moeten worden onderzocht om de uitvoering te verbeteren.

4. Open Access publiceren: We constateerden een wijdverbreid bewustzijn en acceptatie van open access publiceren, voornamelijk gedreven door de aanmoediging en vereisten van financiers en universitaire contracten om de publicatiekosten te verlagen. Financiële barrières vormen echter nog steeds een belemmering voor een bredere uitvoering, met name door bezorgdheid over de dominantie van commerciële uitgevers. Verbetering zou zich kunnen richten op het bespreken van de overgang naar door de gemeenschap aangestuurde publicatie-initiatieven, het vergroten van de erkenning voor Open Access en het delen van gegevens, en het verbeteren van de monitoring. Om deze uitdagingen aan te gaan, is een culturele verschuiving nodig en moet zorgvuldig rekening worden gehouden met de machtsdynamiek in het uitgevers-ecosysteem.

5. Systematische reviews: Geïnterviewden erkenden de waarde van systematische reviews, maar achtten ze onpraktisch vanwege hun tijdrovende aard, de grote vraag naar vaardigheden en kosten, en bureaucratische hindernissen. Alternatieve benaderingen zouden overwogen kunnen worden in specifieke situaties die het veld ten goede zouden komen of om een gesystematiseerde aanpak te gebruiken om gekozen diermodellen/behoeften voor diermodellen in ethische toepassingen beter te rechtvaardigen. Bestaande financierings- en ondersteuningsinitiatieven ter ondersteuning van systematische reviews worden aangemoedigd om te worden voortgezet.

Aanbevelingen: Op basis van de uitgevoerde enquêtes en interviews stellen we de volgende twaalf aanbevelingen voor met betrekking tot dierproeven voor biomedisch onderzoek:

1. **Preregistratie:** Nederlandse subsidieverstrekkers die dierproeven subsidiëren, zouden moeten overwegen om preregistratie van dierproeven voor grote preklinische proeven (d.w.z. proeven voorafgaand aan klinische proeven) verplicht te stellen.
2. **Preregistratie- en ARRIVE-richtlijnen:** Nederlandse financiers wordt geadviseerd om met elkaar in gesprek te gaan over: 1) wat voor soort beloning (of sanctie) moet worden gegeven voor (het niet naleven van) preregistratie of ARRIVE, 2) hoe en wanneer preregistratie op een vergelijkbare manier moet worden gecontroleerd, 3) welke bestaande tools of informatie moeten worden gebruikt om ARRIVE te monitoren en 4) of ze de essentiële 10 of de hele ARRIVE-set toepassen. In elk geval wordt een brede afstemming van het beleid van de financiers aanbevolen.
3. **Preregistratie:** Universiteiten, vergunninghouders en dierenwelzijnsinstanties kunnen preregistratie promoten in universitaire cursussen (bijv. Artikel 9, wetenschappelijke integriteit, het curriculum in het algemeen) en de informatie die aan de onderzoeker wordt verstrekt (bijv. informatie toevoegen aan protocollen/instructies of de website).
4. **DMP's & FAIR:** Financiers kunnen verschillen en overeenkomsten beoordelen tussen de informatie die zij vragen in termen van DMP en FAIR-eisen voor dierstudies om redundantie te voorkomen. Samen met UNL & NFU zouden ze de inhoud van DMP-templates van verschillende onderzoeksinstellingen kunnen onderzoeken om tot meer afstemming te komen tussen wat instellingen en wat financiers vragen. Dit geeft ook de mogelijkheid om te kijken naar discipline-specifieke vereisten.
5. **Open Science:** Open science-gemeenschappen moeten met hun raad van bestuur en decanen overleggen over het opnemen van de naleving van transparantie methoden bij de evaluatie en erkenning van onderzoekers.
6. **Datamanagement:** Decanen en Raden van Bestuur zouden in samenwerking met hun integriteitscentrum of digital competence centres de mogelijkheid moeten overwegen om een 'toegangsprotocol' toe te voegen rond datamanagement voor promovendi en nieuwe medewerkers.
7. **ARRIVE-richtlijnen:** Dierenwelzijnsinstanties kunnen controleren of onderzoeksprotocollen voldoen aan ARRIVE en zien hoe ze ervoor kunnen zorgen dat de inhoud op elkaar wordt afgestemd om geautomatiseerde generatie van methodesecties mogelijk te maken.
8. **Publiceren:** ZonMw/NWO en het ministerie van OCW kunnen de discussie intensiveren over hoe het Nederlandse onderzoekslandschap kan overstappen van het commerciële uitgeverssysteem, inclusief de oprichting van een Nederlandse, door de academische wereld geleide uitgeverij, ondersteund door de overheid en grote Nederlandse financiers.

9. **FAIR, ARRIVE & Open Access:** Tijdschriftredacteuren zouden binnen hun tijdschriften meer beleid voor het delen van gegevens, monitoring en Open Science-beloningen (zoals Open Science-badges) kunnen stimuleren.
10. **Systematische reviews:** ZonMw wordt aangemoedigd om haar financieringsprogramma binnen het MKMD-programma voor het trainen in het schrijven van systematische reviews te handhaven; andere zorgfinanciers wordt geadviseerd om te overwegen soortgelijke subsidieregelingen op te zetten.
11. **Systematisch zoeken:** Dierexperimentencommissies (DECs), Centrale Commissie Dierproeven (CCD) en Instanties voor Dierenwelzijn (IvD) worden aangemoedigd om te bespreken hoe systematisch zoeken de ethische grondslagen van CCD-aanvragen kan versterken.
12. **Systematische reviews:** Universiteiten zouden training over systematische reviews kunnen toevoegen aan hun beschikbare cursussen, in samenwerking met bestaande (Nederlandse) experts en hun pool van experts kunnen vergroten.

Conclusie: Hoewel de respondenten de onderzochte transparantiemethoden beschouwen als waardevolle instrumenten om biomedisch onderzoek in het algemeen en dieronderzoek in het bijzonder te verbeteren, hangt de brede implementatie ervan af van veel factoren. Gebrek aan training, aanmoediging, ondersteuning, middelen, en bewustzijn, net als concurrentie en sociale druk, verhinderen de volledige acceptatie van deze methoden. Om de implementatie ervan te bevorderen, moeten deze transparantie methoden worden geïntegreerd in de opleiding en beoordeling, maar ook erkennen en waarderen door financiers, tijdschriften en instituten. Een grote verscheidenheid aan belanghebbenden moet ter verantwoording worden geroepen om de nodige steun en stimulansen te bieden en normen te bewaken om de uitvoering duurzaam te maken. Met name de implementatie zal de regeldruk en administratieve lasten voor onderzoekers verder doen toenemen en zal daarom niet altijd met evenveel enthousiasme worden ontvangen. Verschillende belanghebbenden in het veld zouden moeten streven naar een verdere afstemming van procedures en beleid. Dit kan helpen om de administratieve last te verminderen en de harmonisatie van eisen te vergroten, naast dat het de intrinsieke motivatie van wetenschappers kan verhogen om deze transparantiemethoden als gangbare praktijk te omarmen. Tot die tijd is het belonen van vrijwillige inspanningen wellicht effectiever voor de implementatie dan het opleggen van sancties wanneer verplichte methoden niet (volledig) worden nageleefd.

3. Introduction

In the realm of biomedical sciences, where breakthroughs pave the way for advancements in healthcare and understanding (human) biology, an issue has emerged already two decades ago: the replication crisis. This crisis, characterised by the inability to reproduce research findings consistently, has sent shockwaves through the scientific community, challenging the very foundation upon which biomedical knowledge is built. At its core, the replication crisis underscores a fundamental dilemma: can the findings of a scientific study be trusted if they cannot be replicated? In the pursuit of scientific truth, replication serves as a litmus test, providing validation and reinforcing the reliability of research outcomes. A growing body of evidence suggests that many findings in the biomedical literature fail to stand the test of replication, raising concerns about the reliability and credibility of scientific research in this field (Freedman et al., 2015, Jarvis et al., 2016). This problem with replicating experimental studies also stretches out to research involving laboratory animals (Frommlet, 2020). This has led to strong criticism of methodological weaknesses in animal research, which contributes to the increasing concerns about the validity of animal models as proper models to mimic human (patho)physiology (Pound et al., 2018). In this report, we focus on the replication crisis in the context of experimental research using laboratory animals.

To counteract this crisis, efforts have been deployed to improve the quality and transparency of animal studies, which in part takes form under the Open Science umbrella. At its essence, Open Science advocates for a departure from traditional closed-door practices towards a more inclusive and transparent approach to research. By making research outputs openly accessible and fostering collaboration among researchers, Open Science not only enhances the reproducibility of findings but also accelerates the pace of scientific discovery. Moreover, Open Science promotes the adoption of rigorous methodological practices and robust statistical analyses, thereby mitigating the risk of spurious or irreproducible results (Arza et al., 2018).
Open science encompasses a set of methods ensuring transparency from design, during conduct, up until publication, which improve animal research (Janssens et al., 2023). At design, a robust and transparent preparation will promote a robust methodology and mitigate future errors. Six of the most referred to transparency methods are: preregistration, data management plans, FAIR data, ARRIVE guidelines, Open Access and systematic reviews. Existing guidelines (e.g., PREPARE, a planning checklist) or methods like preregistration, the act of registering a study protocol before the start of the experiments, and Data Management Plans (DMPs) are great ways to incorporate transparency into design. The PREPARE guidelines push researchers to think in depth about their design and pave the way for a robust project. By displaying the hypothesis, measured outcomes and the statistical plan before the start of a study, preregistration can diminish biases, such as selective outcomes reporting, but also questionable

research practices, like HARKing (Hypothesis After Results are Known) or p-hacking, (Menon et al., 2023). Preregistration platforms also reduce the prevalence of publication bias, by making studies available regardless of the significance or the direction of their results (e.g. Preclinicaltrials.eu, Animal Study Registry). DMPs are detailed plans made prior to the start of the research to stimulate proper planning of data management by addressing how the data will be (and is) managed, described, stored, shared with others and archived long-term (following field standards). It is a living document, which should be updated during the research, to reflect (changes in) choices made. This includes for instance in which formats the data will be shared and stored, or which standard will be used to describe the data as to make it understandable to all. This practice goes in line with the FAIR principles, consisting of making data Findable, Accessible, Interoperable and Reusable (FAIR; Wilkinson et al., 2016).

The intention of FAIR data is to ensure that everyone, i.e. both people and computers, can understand, read, and reuse a data set, dependent on the conditions set by the original researcher and ethical and legal requirements. The 'Accessible' part of FAIR contains the information of whom under what conditions can access the data. This could also mean that the data contains privacy-sensitive information, and is therefore not accessible to all. Therefore, handling data according to these principles is named "FAIRification of data" or "making data more FAIR". When considering the 'FAIRness' of data, it is important that data is in a non-proprietary format (e.g., .csv instead of .xlsx), with sufficient documentation, such as a read me file, explaining the abbreviations and variables, controlled vocabularies and machine-actionable metadata. It is also key that existing standards are used as much as possible (e.g. known standard to name a certain outcome), and that each file possesses a persistent identifier (like a DOI) to make them easily findable. Importantly, full FAIRification of data is not trivial and goes beyond regular data management; even though FAIR data becomes more and more accepted, it can be a major effort to fully apply all FAIR principles upon publication, as know-how on how to become FAIR is not widespread yet. Therefore, FAIR data is considered an optimal goal to achieve, but thus far hardly ever met for 100%.

Making research available can furthermore be done by publishing Open Access, which means it is freely accessible online for everyone. An advantage of Open Access publication is that these articles are more immediately recognized and cited by peers than non-Open Access articles, even when published in the same journal (Eysenbach G. 2006). Open Access is therefore considered to benefit science by accelerating dissemination and uptake of research findings and advocated within the scientific community, amongst others at the Dutch Open Access platform. Previously, readers paid for access to articles. Nowadays, many journals offer Open Access by increasing the article processing charge (APC); the extra Open Access fee can vary greatly from one publisher to another (roughly € 2,000 to € 10,000) (Brainard, 2021). According to the directory of Open Access journals, more than 20,000 journals are Open Access, of which 13,000 do not apply fees at all (around 3,500 of which are science journals); this is

referred to as “diamond Open Access”, as no fee has to be paid. These journals are often not run by commercial publishers, but for instance directly by academic institutions.
Furthermore, it is important to note that even when making manuscripts and datasets available, it is crucial that they adhere to specific reporting standards. This ensures clarity and facilitates reproducibility. In the case of animal research, the ARRIVE guidelines serve as the foremost reporting standard. They encompass twenty essential elements of animal studies, such as details about the animals used, their care, blinding, randomisation, and sample size calculation. Initially introduced in 2009, an updated version, ARRIVE 2.0, was released in 2020. This revised edition is divided in two sets of ten items: the *Essential 10* comprising the fundamental requirements for any manuscript describing animal research to ensure reliability, and the *Recommended Set*, which provides additional contextual information. For a full description of the ARRIVE guidelines, look at the ARRIVE website.
In addition to these methods, systematic reviews of animal studies are a great way to provide an overview of existing studies on a specific topic. A systematic reviews is a high-quality, in-depth analysis of all the existing research. It follows a structured, scientific approach which includes a well-defined research question, followed by a comprehensive search for all relevant studies, using reliable sources. After a rigorous selection based on predetermined criteria, the selected studies are evaluated for their strengths and weaknesses, including potential biases. Finally, findings from all studies are summarized and analysed to provide an overall picture of the evidence on the topic. Because of the structured approach, they enable the identification of research gaps, assess the relevance of particular models, and provide the highest level of evidence by combining all existing data on a given topic. These reviews not only scrutinise individual study quality, but also endeavour to contextualise findings within the broader landscape of research, enhancing our understanding of the subject matter. Although writing a systematic review is time-consuming, it can be highly beneficial and rewarding in the long term, as it enables researchers to contextualize new experiments appropriately and may help select the most suitable model for investigation. Systematic reviews are very valuable for animal studies, as they can help to prevent unnecessary repetition of animal experiments and thereby directly contribute to 3R implementation (Menon et al. 2021). As such it can be regarded as fulfilling the requirements of the Dutch law on animal testing, as well as the EU Directive 2010/63/EU of the European Parliament and the Council.

Assignment

In the face of mounting concerns surrounding the reproducibility of biomedical research, embracing the principles of Open Science offers a promising pathway forward. By fostering transparency, accountability, and collaboration, Open Science has the potential to not only address the reproducibility crisis but also foster a culture of innovation and excellence in biomedical research. This movement is followed and

supported by the Dutch Government, who finances large Open Science initiatives like Open Science NL (since 2023), which has the primary goal to make Open Science the norm in the Netherlands by 2030, or Health-RI (since 2021), which is focussed on improving the reuse of health data for policy, research, and innovation. Brewing from a growing interest, in 2019, the Dutch House of Representatives (*Tweede Kamer*) passed a motion asking the government to investigate ways to increase the transparency and quality of animal research. In particular, the government was asked to investigate the possibility of making preregistration of research protocols mandatory for studies using public funding. In that context, ZonMw was given an assignment by the Ministry of Education, Culture and Science to set up a pilot study, which is described in the current report. ZonMw was regarded as a suitable party to conduct this study, as it is in several of its funding schemes already requesting, recommending or facilitating various transparency methods. ZonMw also continuously questions the status quo and assesses how preclinical research could be improved further. A recent example of this endeavour is the publication of the Knowledge Agenda "Transition towards Animal-free Innovations" in 2023, which addresses why existing animal-free methods do not yet find their way to implementation and what can/should be done to improve this. Another example is the event "Transition to Animal-free Innovations: Ambition vs Realism", which ZonMw organized in December 2023 together with the NCad (Netherlands National Committee for the protection of animals used for scientific purpose) to stimulate discussions on replacing animal studies with novel animal-free approaches.

The current document is a report of the aforementioned assignment of the Ministry of Education, Culture and Science to ZonMw. Basis of this report is a pilot study in which preregistration and the ARRIVE guidelines were made mandatory for animal research in a selection of funding schemes from ZonMw and NWO. How these new measures were received and appreciated by the researchers was evaluated, next to the impact of transparency methods that were already mandatory, such as DMPs and Open Access publication. Next to researchers, it was considered relevant to also include the views of other stakeholders of preclinical research, namely data stewards, members of animal welfare bodies, journal editors, deans, and funders. This broadens the view on these transparency methods and could enable the identification of the barriers and facilitators related to their adoption, with the objective of understanding the requirement and potential impact of future implementation strategies and policies. Additionally, the study aimed to prevent the adoption of methods considered unnecessary by researchers and stakeholders. The primary outcome of this effort would be the development of a set of recommendations tailored to various stakeholders, advising on the appropriate course of action concerning these transparency methods. All of these requirements are met in this extensive report of the pilot study, which was conducted between 2020-2023.

Problem definition

We hypothesise that several factors are influencing the implementation of transparency methods regarding animal research at several levels (researchers, stakeholders, and research culture). As some Dutch funders are requesting or advising the use of several transparency methods to their grantees, an in-depth analysis of the grantees experience could shed some light on the process and problems encountered during implementation. It might also indicate the necessity to remove certain methods, e.g. ineffective conditions that only lead to a higher bureaucratic burden for researchers.

Research goals

Within a time scale of three years, we aimed to identify barriers and facilitators to implement six transparency methods in (the Dutch) biomedical research, according to the experience of Dutch funder grantees. The transparency methods of interest are Data Management Plans (DMPs), preregistration, FAIR data principles, adherence to ARRIVE guidelines, open access publishing, and systematic reviews. First, by collecting researchers' feedback and experiences via surveys and interviews. Second, by questioning stakeholders (i.e. data stewards, members of animal welfare bodies, journal editors, deans, and funders) on their perspectives or plans to implement the methods, their opinions, and solution for reinforcement via interviews. Ultimately, this project will provide recommendations to a large panel of stakeholders on future steps regarding the transparency methods for animal research.

Research questions

1. What are the barriers and facilitators that researchers face regarding the use of the six transparency methods? (Researchers' setting)
    a. What resources, incentives and rewards do researchers have to implement transparency methods (e.g. guidance from their institute, internal platform to respect FAIR data) (Opportunity & Motivation)
    b. What enables or prevents their awareness/knowledge/ease of use (e.g., no previous training on high-standard design, time constraints, lack of funding) (Capability)
    c. What would they need to adhere further to the transparency methods (Capability, Opportunity, Motivation)?

2. What are the stakes and opinions of stakeholders on the six transparency methods? (Stakeholders' setting)
    a. What is their opinion on the usefulness, necessity and importance of the transparency methods?
    b. What did they already set in place to implement the transparency methods? (if any)
    c. What could they/would they like to improve or plan for the future?

4. Material and Methods

4.1 Theoretical Framework

We focus on the implementation of six transparency methods by Dutch funders and how these methods are perceived and applied in the Netherlands. To investigate this topic, we relied on existing insights from implementation research. Implementation is defined as the operation of utilising or integrating innovation into a specific setting, here the implementation of the six transparency methods in research (Rabin et al., 2008). Implementation frameworks can be divided into three groups (Nielsen et al., 2015).:

1) the guidance of implementation,
2) comprehending or explaining factors that influence implementation outcomes,
3) evaluating the implementation.

In our study, we fall within the second category as we aim to understand factors influencing implementation in context (Peters et al., 2013). Considering the multifaceted nature of implementation and its prospective context, we combine two implementation frameworks, namely the COM-B model and the Consolidated Framework for Implementation Research (see also Figure 1):

The COM-B Model

To generate Behavioural change (B), individuals require Capability (C), Opportunity (O), and Motivation (M) (Michie et al., 2011). In our case, a grant that required researchers to comply with a certain method could be seen as an *Opportunity* to apply this method. However, to ensure sustainable change, we also require an individual's *Capability* (i.e. knowledge and skills) and *Motivation* (i.e. emotions and perception). Capability is influenced by one's ability to execute the intervention and external factors increasing that capability (e.g. courses, guidance, resources). Opportunities represent an array of external factors that can prompt behaviour (e.g. reward, social pressure, habits within an institute). Together, capability and opportunities influence motivation, which will then shape behaviour, and behaviour will subsequently affect an individual's capacity, perception of opportunity, and motivation.

Consolidated Framework for Implementation Research

To put this in a broader context, including institutes and stakeholders, we used the Consolidated Framework for Implementation Model (CFIR) (Damschroder et al., 2009), as it looks into the characteristics of the interventions (CFIR I), perception of the adopters (CFIR IV), inner and external factors (CFIR II & III) and the strategies and means put into place for successful implementation (CFIR V).

Combined with COM-B, we define two implementation settings for our study (see also Figure 1):

1. <u>The researcher setting:</u> researchers are influenced by their perception of the transparency methods and their own capability (Capability), as well as inner factors coming from within their institute, external factors coming from stakeholders and the social contexts (outer setting) (Opportunity & Motivation). The success of the implementation will also depend on the plan in place at their research organisations (if any).

2. <u>The stakeholder setting:</u> stakeholders, when facilitating or demanding/requesting the methods, are also influenced by their own perception of the transparency methods (e.g. usefulness), inner and outer factors (e.g. the support they receive/give to help researchers, external policies from the government, stimulation from other stakeholders, societal pressure). The success of the implementation will again depend on the strategy in place to implement these methods.

Altogether, these factors will impact the implementation of the transparency methods and potentially the transparency and quality of preclinical research.

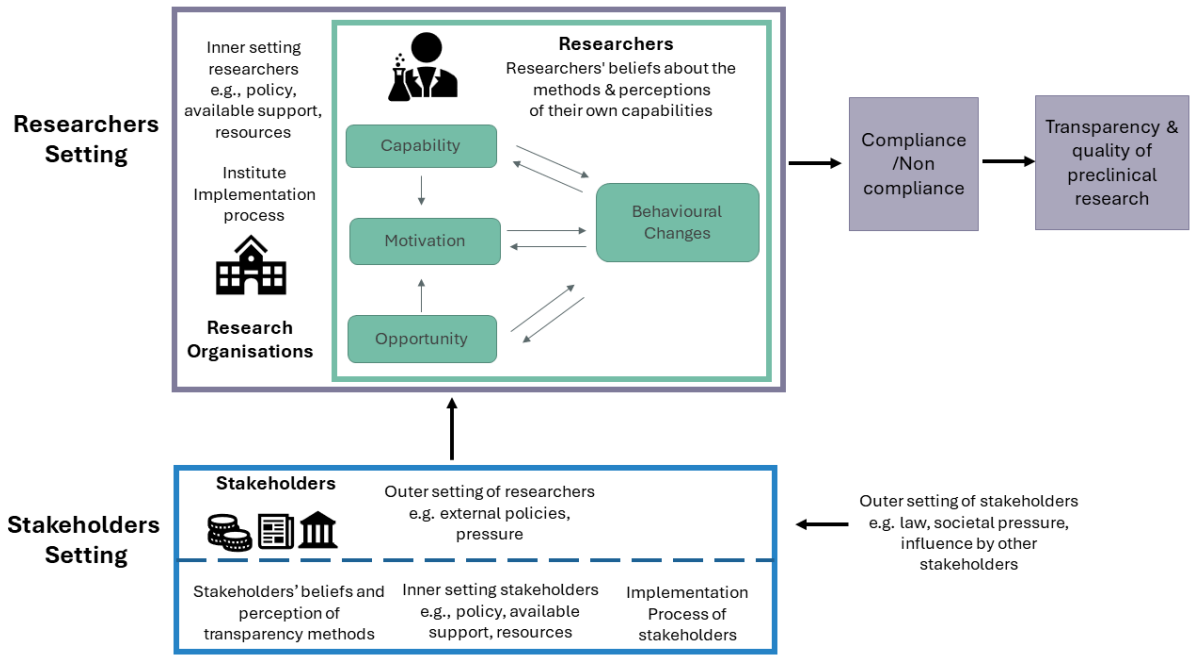

Figure 1: Resulting conceptual framework

4.2 Approach

We used a mixed-method approach combining questionnaires and semi-structured interviews. First, we targeted researchers who received a grant from ZonMw, NWO or the Hartstichting (the Dutch Heart foundation) involving animal research, requesting compliance with one or more transparency methods. Secondly, we also focused on stakeholders stimulating the use or implementation of the transparency methods, i.e., data stewards, heads of institutes, funders, journal editors, and members of animal welfare bodies. This approach provides us with an extensive overview of actors involved in the implementation of transparency methods for animal research.

4.3 Sampling Strategy & Recruiting Participants

We used purposive sampling to select participants. Researchers were chosen depending on the grant they received and their project's fit with our timeline. In total, we included ten grant types and multiple years (see Table 1 for an overview of the grant schemes included in this study and the questionnaires they were invited to fill in). Researchers could state in the questionnaire if they wished to participate in an interview, and if their response was positive, they were provided with more information.

Stakeholders were chosen based on their relationship with researchers and their institute; we also asked interviewees to connect us with relevant stakeholders to interview.

Participants were recruited via e-mail and sent a reminder two weeks after the invitation. All e-mail addresses were obtained via funding agencies or our network. We did not aim to achieve data saturation but to collect as much data as possible. For the stakeholder interviews, we interviewed at least four individuals per group.

4.4 Data collection, processing and analysis

The questionnaires and semi-structured interviews for researchers complemented each other with the interviews providing greater detail. To enhance reliability, each questionnaire and interview guide was piloted by experts or ZonMw program managers.

Online questionnaires

We designed the questionnaires on "Questionpro," a free platform (https://www.questionpro.com/). There were five questionnaires in total, covering all of the investigated methods:

- Preregistration
- DMPs and other methods used at study design (e.g. PREPARE, systematic reviews)
- FAIR data
- ARRIVE guidelines
- Open access publishing

Questionnaires had both closed (dichotomous, scaled, multiple choice) and open-ended questions. Scale questions consisted of seven-point Likert scales, with ends being "completely disagree" and "completely agree". All questionnaires followed a similar structure based on:

1) Previous knowledge and habits,
2) Opinions and experience with the transparency methods,
3) External and internal support to implement the methods.

The full questionnaires are available in Appendix S1, with questions differing per survey.

By completing the questionnaires, participants gave their consent for their answers to be used in reports or publications. If, within any open question, researchers mentioned something that could make them recognisable (e.g. name of colleague, institute), this information was removed to anonymise them. Questionnaire data were exported to Microsoft Excel. Open-ended questions were analysed by content analysis, while closed questions were summarised with frequency counts and calculation of means and median. All analyses were conducted by one investigator.

Grant scheme	*Research area*	*Aim*	*Time of project*	*Max amount (€)*	*Target*	*Required Position to apply*	*Had to comply with Preregistration & ARRIVE*
Antibiotic Resistence (ABR) - ZonMw -	Bacterial Resistance in fundamental and applied research	Investigate mechanisms for inducing and transmitting antibiotic resistance, targets for new antibiotics and alternatives, optimising antimicrobial therapy, diagnostics	5-6 years	13M in total	Groups and individuals	Postdoctoral	Suggested
Joint Programming Initiative on Antimicrobial Resistance (JPI AMR) - ZonMw -	Antimicrobial Resistance in fundamental and applied research		2011-2025	11,5M in total		Postdoctoral	Suggested
Dementie Fellowship - ZonMw -	Dementia & Alzheimer	prevent and treat dementia and to ensure a better quality of life for people with dementia and their loved ones	3-5 years	300k	Individuals	Postdoctoral 0-5 years after PhD	Mandatory
Off Road 2016, 2019 & 2021 - ZonMw -	Health Research and Development	Out of the box research, test hypothesis behind unexpected breakthrough	1-1.5 years	100k	Individuals	Postdoctoral, 2-6 years after PhD	Mandatory (Off road 2019 & 2021) Suggested (Off road 2016)
Hartstichting	Cardiovascular Disease	Improve prevention, treatment or living with cardiovascular diseas	2-5 years	700k	Individuals	From specialist in training till young professors	Suggested
Open Competition 2019 & 2020 (Part of the NWO Open Competition program)	Health Research and Development	Good quality collaborations	4-5 years	1M	2 or more research groups	Assistant, Associate or Full Professor	Mandatory (Open Competition 2020) Suggested (Open Competition 2019)

Grant scheme	*Research area*	*Aim*	*Time of project*	*Max amount (€)*	*Target*	*Required Position to apply*	*Had to comply with Preregistration & ARRIVE*
TOP Subsidy							Suggested
Veni 2018-2021 (Part of the NWO Talent program)	Health Research and Development	Promote innovation and support at various career stages	Max 3 years	280k	Individuals	Postdoctoral, 0-3 years after PhD	Mandatory (Veni 2021) Not mandatory but suggested (Veni 2018-2020)
Vidi 2017-2021 (Part of the NWO Talent program)			Max 5 years	800k		Postdoctoral 3-8 years after PhD	Not mandatory but suggested
Vici 2017-2021 (Part of the NWO Talent program)			Max 5 years	1.5M		Postdoctoral 8-15 years after PhD	Not mandatory but suggested

Table 1: Grant schemes targeted in this study, which are run by ZonMw, the Hartstichting, or NWO. Preregistration and adherence to ARRIVE Guidelines was either suggested to or made mandatory for awardees of the various grant schemes. Generation of a DMP and Open Access publication are mandatory for all grant schemes by all funders, whereas adherence to FAIR principles are encouraged.

Semi-structured Interviews

We designed eight interview guides: three interview guides for researchers and five interview guides for stakeholders (one per group). The guide for the researchers addressed the transparency methods at the beginning of the study (DMPs & preregistration), during their study (FAIR/DMPs), and at the end of their study (FAIR, ARRIVE and Open Access). For researchers, interviews were semi-structured with open questions to address their experience with using the transparency methods, including the support they received, their views of the method, and its perceived necessity for the scientific community.

For stakeholders, the interviews consisted of open questions focusing on:

- their (lack of) current recommendations/requirements regarding the transparency methods;
- their influence on the researchers/users/grantees to adhere to these requirements and influence on other stakeholders;
- external influence on their own policy exerted by other stakeholders (e.g., from their supervisor/management, inspirations and stimulation from other institutes/funders, the government, societal pressure, feedback from researchers);
- and their views on the future of the field of animal research.

We also asked questions about their general work, how they interacted with researchers, and the communication of goals and directives within their organisation. To note: data stewards were not asked questions about ARRIVE.

Prior to the interviews, we sent an informed consent form to all interviewees (Appendix S2), compliant with the World Health Organisation informed consent form template for qualitative studies. Participants had the opportunity to ask questions before signing. They were informed that withdrawing from the study was allowed at any point and without any consequences.

Interviews were conducted and recorded online using Zoom and lasted 45-90 minutes. Only the interviewee and investigator conducting this pilot study partook in the call. Field notes were written during and/or after the interviews and were anonymised. After the interview, audio recordings were transcribed verbatim using Microsoft Word. All files received a random number via www.random.org, and any mention of name, institute or any other information personal to the interviewee was removed. To make the different groups distinct, each participant was also given an abbreviation in addition to a random number. Table 2 below summarises the abbreviations given. The resulting transcripts were returned to each participant for comments and/or corrections.

Table 2: Interview's anonymous codes explained

Abbreviations	Signification	Corresponding groups
PS	Pilot Study	Researchers
PSD	Pilot Study Dean	Deans, head of institutes/departments
PSdata	Pilot Study Data Stewards	Central or Local Data Stewards, Research data management support
PSIvD	Pilot Study Instantie Dieren Welzijn	Member of an Animal Welfare Body
PSF	Pilot Study Funder	Funders representative, program managers
PSJ	Pilot Study Journals	Journal editors and publishers

Analyses were conducted in Atlas.ti (Version 8.4.15.0). Thematic analyses were based on themes from the COM-B and CFIR framework and themes emerging from the data.

Research Framework

Figure 2 provides an overview of the structure of this study. Part A shows the core concepts we researched or action we undertook as background preparation for this project. Part B corresponds to the questionnaires and interviews conducted with our two interviewee types, while part C refers to the analyses including the surveys, interviews, inventory, and assessment. Lastly, part D represents the goal of our study: identifying barriers and facilitators to the transparency methods and the formulation of recommendations.

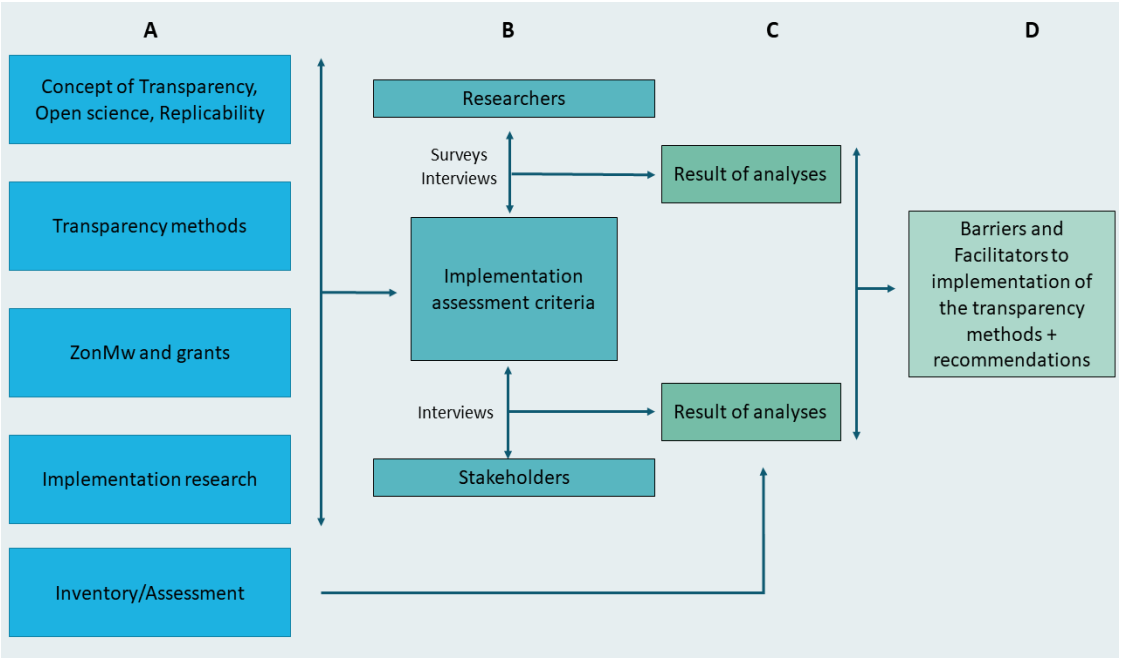

Figure 2: Research framework showing the different steps of the case study

5. Target population and survey reception

Surveys and interviews were conducted between 2021 and 2023. The target population consisted of 137 potential participants for surveys on Study design (incl DMPs, systematic review and PREPARE), FAIR data, and Open Access publishing; 27 potential participants for the ARRIVE guidelines survey and 23 for the preregistration survey. Overall, group response rates varied widely, between 6.5% and 56.5% (Figure 3).

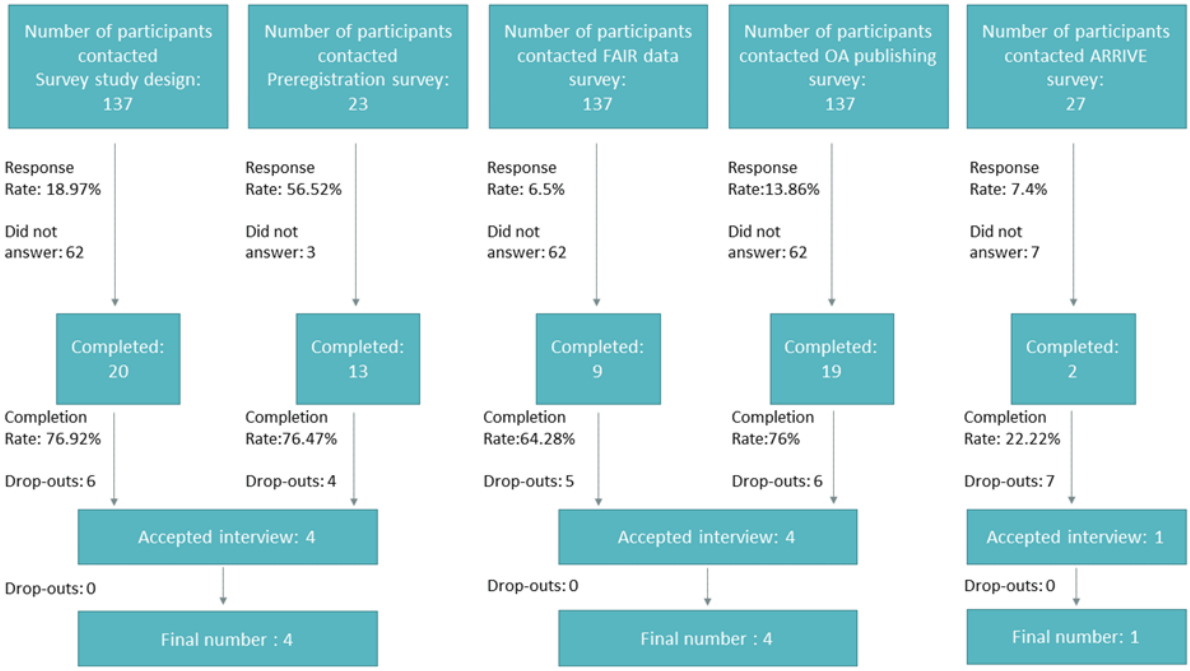

Figure 3: Participants flow chart for all five surveys

Across all five surveys, we collected 63 complete answers (91 answers with the mid-surveys drop-outs) and performed 7 interviews (4 of them on different topics; i.e. one on ARRIVE and Open Access, one on Study design, FAIR & Open Access, two on preregistration and study design). Completed questions from incomplete surveys were included in the analysis. For a more complete overview of the number of respondents per question for each survey, please refer to Appendix S3.

Participants were in majority academics (n=53), of which 19 assistant professor, 11 associate professors and 23 full professor, followed by postdoctoral researchers (n=13) and PhD students (n=7). This distribution reflects the type of subsidy granted to these participants, with Vidi (n=19), Offroad (n=17) and Veni (n=14) in the top three (Figure 4).

In the stakeholder interviews, 5 groups participated: funders (n=7; 5 Dutch, 2 German), data stewards (n=7, including one information specialist), members of animal welfare bodies (AWB) (n=5), deans/heads of institute (n=6), journal editors and publishers (n=4).

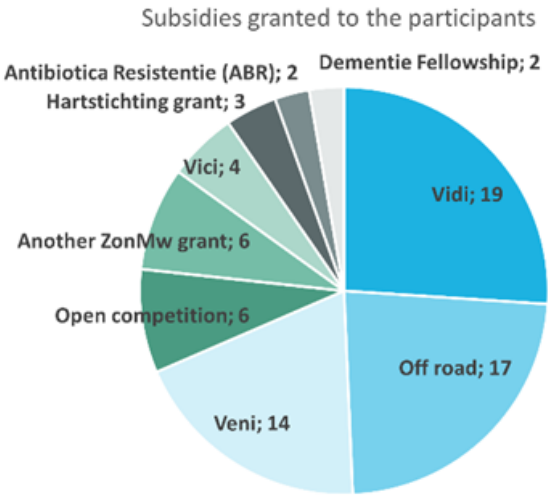

Figure 4: Subsidy types granted to the participants (see Table 1 for more details on each grant scheme).

In the next chapters, we present the results from the surveys and interviews per transparency method. To avoid confusion, participants of surveys are called "respondents" or "surveyed participants", while for the interviews (of researchers and stakeholders) they are referred to as "interviewees" or "interviewed participants" with their anonymous number.

Each chapter ends with a summary box and a set of recommendations based on surveys and interviews. The recommendations were reviewed by external reviewers who did not partake in the study, together with two ZonMw employees who did. The complete set of recommendations for all investigated methods is summarized in Chapter 8.

Limitations and considerations

Given the breadth of the topics explored - six different methods across six groups - it was challenging to dive deeply into each individual method. Our objective was not to achieve data saturation but to gather as many responses as we could given time constraints. This choice was also motivated by the multitude of research instruments (i.e. 5 surveys and 8 interview guides) and topic addressed, which covers a large panel. Yet, we realise the impact this may have on the data and take this factor into account in the analysis and report of the results. This is the case for some of the surveys that received a low number of responses, complicating the generalisation of results. Also, it is reasonable to assume that respondents who completed the surveys or participated in interviews are more knowledgeable or in favour of transparency methods, creating bias. Besides, surveyed researchers were ZonMw's grantees, and were asked by the investigator (a ZonMw employee) to give feedback on ZonMw's requirement; this could have created further bias. Lastly, while each instrument (e.g., surveys, interview guides) underwent piloting, data collection and analysis were undertaken by a single individual without duplication. Independent duplicate assessment could have further underscored the robustness of the data.

6. Preregistration of animal studies

Preregistration of animal study protocols was known by only 6 respondents out of 16 and was never applied before their current grant (Figure 5). PREPARE guidelines were also mostly unknown and infrequently used. Only two respondents could give us further information about their experience with PREPARE. These additional results are available in Appendix S4.

Surveyed researchers perceived preregistration as rather impactful on transparency (n= 13/16 agreed), and to a lower extent on the quality of the research (n=8/16) or the potential reduction of unnecessary animal use (n=6/16) (Figure 6). However, preregistration methods were seen as an administrative burden by most participants (n= 12/16), whereas their usefulness was perceived in a mixed/neutral way.

Some of the interviewed stakeholders were familiar with preregistration and many across all groups were in favour of using it for (all) animal research, especially due to its value for transparency and reproducibility. Some even mentioned that preregistration, as part of open science and ethical responsibility, could be used to justify (funding) animal research to society (PSF38, PSIvD72, PSJ94). In contrast, two interviewees were really sceptical about preregistration, one of whom did not know about the concept before the interview (PSJ87, PSIvD55).

> *I think that it's a good point, like in the human research, to register the initial study designs and protocol of experiments. So that later in the publication you can also relate to what was the original aim and amount of animals needed and so on, and what adaptations have been made or not during the process – PSD17*

> *"You have to preregister because that's almost another defence mechanism to society. 'Listen, if we do animal studies, we will always be open about this and you can find everything we did. You can find there, even when we did not publish about it, even when things went wrong. You can find it there'. You need that openness. To be able to defend it in the future that you use animals at all, I think." – PSIvD72*

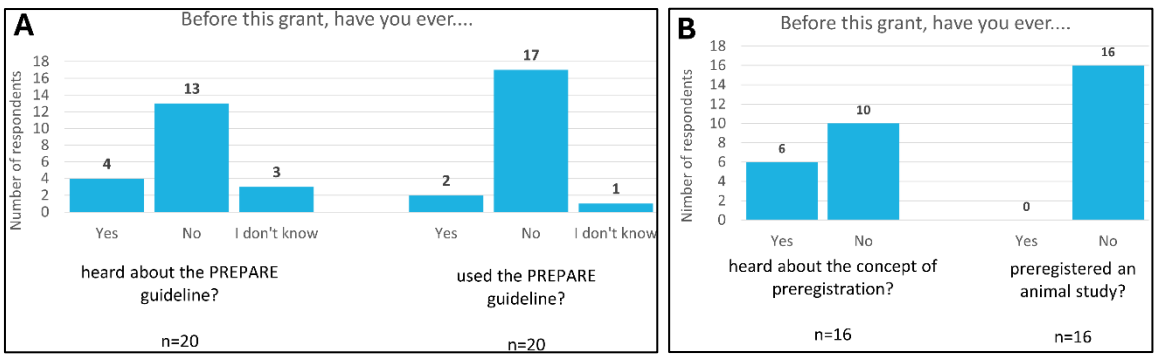

Figure 5: *Previous usage and knowledge of the PREPARE guidelines and Preregistration by researchers. A: PREPARE guidelines, n=20; B: Preregistration of animal studies, n=16*

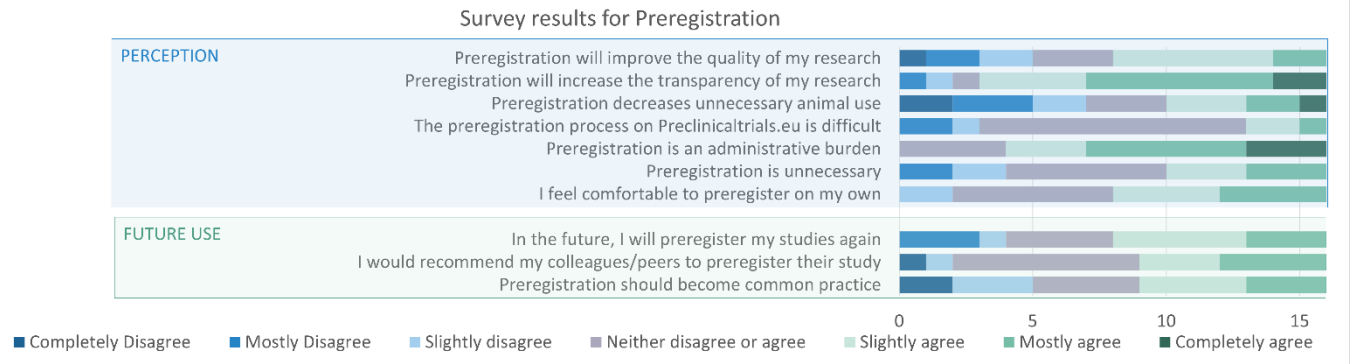

Figure 6: Survey results for Preregistration of animal studies; n = 16

However, some reservations were voiced by the interviewees, such as the notion that preregistration might be less useful for fundamental research (PSD100, PSIvD72) or early drug discovery studies (PSD22) because of their exploratory nature. It was argued that confirmatory research would be more fitted for it, due to the structure around this type of trials (PSF79). Across groups, quite a few interviewees claimed to already promote and/or facilitate preregistration locally (PSIvD003, PSIvD37, PSIvD72, PSD16, PSD22, PSD47, PSD100, PSdata95), either by having information on their website, organising webinars or recommending it to researchers directly. Regarding the funders, many mentioned their recommendations for preregistration (PSF14, PSF21, PSF38), and the presence of information in brochures/calls, but only two (of the same funding agency) had a clear requirement for a specific call regarding confirmatory studies (PSF05 & PSF79). Within that specific call, monitoring mechanisms were established to ensure that preregistration is indeed performed and part of the money is only provided once preregistration had been confirmed (i.e. registration link is sent to funding agency).

Most surveyed participants did not have an opinion on the process's difficulty when using the platform Preclinicaltrials.eu (n=10/16 neither disagreed or agreed on difficulty), however only half felt comfortable to preregister without the help of others. Explanations to the aforementioned negative and overall neutral answers might be related to the limited knowledge about and/or experience with preregistration of animal experiments, as well as the lack of external promotion. Indeed, only 2 surveyed participants out of 15 stated that they received sufficient information on why preregistration is important and on how to preregister. This lack of information was also reflected in the survey's open text answers, as some of the participants voiced concerns that preregistration would negatively affect creativity in the experimental process. These worries were also voiced and heard by interviewees; the barriers for this method lie in beliefs researchers have (i.e., getting scooped, not being able to change protocol), lack of awareness and time/added bureaucracy. This is in line with previous studies showing that strong beliefs are held against preregistration when awareness or experience is low (e.g. prevent flexibility, fear of

getting scooped) (Wieschowski et al. 2020; van der Naald et al. 2021). Positively, hearing researchers out and explaining them the concept in more detail seems to already solve part of these barriers.

> *I think pre-registration is not something that a lot of researchers are really aware of yet. It's definitely becoming more [...] That's catching attention, but that's still in development – PSdata95*

> Talking about one-on-one consultation PSF05 have with researchers: *"People typically come with a lot of questions or what they hear; they might be scooped, the embargo is not long enough, and so on and so forth, and this is an additional burden and whatnot. And typically, as soon as we engage with them but also bring them together with stakeholders from different platforms, this changes – PSF05*

Several solutions exist to reduce these concerns and facilitate preregistration, although they are not all bulletproof. For instance, one solution is to use existing work protocols to preregister, so as to gain time. However, the documentation used for work protocols does not always comply with the preregistration template (in content or structure), which still requires researchers to add new information. In the case where an export can be set up, i.e., another solution to speed up the process by exporting data from the Animal Welfare Body (AWB) software (eg. PRIS) to the registration platform, there is a risk that the export process becomes ineffective if the original template changes.

> *"So you have to make adjustments again, which can be challenging [...] many systems will look different in a year from how they are now, which can have consequences for your transfer table and integration system"- PSIvD37*

Ethical procedures were discussed (sometimes in relation to preregistration), with interviews highlighting their time-consuming nature and discrepancies across institutions in management practices and committee alignment (PS33, PS66, PSIvD37, PSIvD40, PSIvD55, PSIvD72). While acknowledging the necessity of ethical procedures to justify animal research, interviewees expressed concerns about redundancy (PS33, PSIvD40) and acknowledge heavier requirements since 2014, although with improved welfare (PSIvD37). Suggestions for improved guidance, rather than shortening the procedure, was made notably for the application to the CCD (Centrale Commissie Dierproeven; Central Authority for Scientific Procedures on Animals) (PSIvD55, PS33). Moreover, several interviewees noted discrepancies across institutions in how the DEC (Dierexperimenten-commissie; Animal Experimentation Committee), and AWB handle ethical procedures, including variations in information requests, software utilisation for AWBs (PSIvD37, PSIvD72), and evaluation process (PS33, PS66). One participant in particular stated that there was "no transparency within the DEC committees" and that guidelines to harmonise evaluation nationally would be beneficial (PS33). Further potential complications arise from the distinct roles assigned to each group: the DEC assesses ethicality and can request modifications to documentation, while refraining from providing guidance on content but offering advice to the CCD regarding license approval. Conversely, the AWB

serves as both advisor and supervisor to researchers, and communicates about administration with the CCD, though their role does not include assessing ethicality. The AWB can advise the DEC and the DECs together are in communication with the CCD to align the ethical review process. Besides, the current ethical procedure does not consider grant acquisition or preregistration as positive factors (PS33, PSIvD37), potentially leading to study rejection despite acceptance elsewhere. Thus, enhanced communication and alignment within and among ethical committees and funders would streamline the procedure (PSIvD37, PSIvD55) and potentially facilitate new methods, such as preregistration. Overall, researchers perceived navigating through these various legal requirements as burdensome, which may deter proactive engagement in additional methodologies.

> *"Sometimes they say, "We have to jump through hoops all the time. First, we jump through the hoop of the funder, then the hoop of the IVD [=AWB], and then again through the hoop of the DEC." PSIvD37*

Suggestion from members of the AWB was to use the obligatory non-technical summaries (to inform society and lay people) as an alternative to "simple" preregistration. Although less accessible and detailed than full preregistered protocol, non-technical summaries are often made available and encouraged in several research organisations (PSDIvD003, PSIvD55, PSIvD72). Otherwise, publishing a registered report could also be an option; registered reports are a publishing format where study protocols undergo peer-review before the research begins. If the protocol is accepted, the final publication will be accepted by the same journal disregarding the results. Two journal editors reported that registered reports are encouraged within their journals (PSJ40 & PSJ04). In certain circumstances, a registered report could be more rewarding than simple preregistration (PSJ04). Lastly, one member of the AWB suggested for monitoring that funders could demand the existing research plan and check with the AWB for its accuracy (PSIvD40); although it could help to ensure that what was planned was indeed delivered, it would reduce the benefit linked to transparency, as the protocol would no longer be publicly available.

For preregistration to go forward, several potential changes to the current status quo could be considered (these were either suggested by researchers or stakeholders). Surveyed participants also provided encouraging/discouraging factors and potential improvements Dutch funders could make (Table 3):

Show the benefits and safety measures

As awareness is an issue, more education would be crucial to show researchers the benefits of the methods, but also showing the safety measures in the process to avoid getting scooped.

One-on-one consultation to enhance awareness and confidence, as suggested by PSF05, could also prove beneficial, alongside ongoing efforts to streamline preregistration processes through solutions like protocol alignment, guidance, and export mechanisms.

Additionally, enabling others, such as animal welfare body members, to preregister on behalf of researchers could alleviate bureaucratic burdens.

> *"They need to be better educated on it and then it needs to be easy to do. And if those two things happen, I think it, there are little downsides to preregistration there. – PSJ40*

Make it required and rewarded

Given the benefits of preregistration of animal experiments (Van der Naald et al. 2022) and supported by the interviews, preregistration could become required when relevant (e.g. for large preclinical confirmatory trials). However, requirements come with responsibilities to monitor and enforce the method. Journal editors voiced the concern that researchers may not submit their article to a given journal if it demands preregistration, whereas other journals do not. It was advocated that preregistrations should rather be a biomedical-wide requirement, as only recommending preregistrations seems not sufficient. Some participants said that preregistration could be demanded by funders, but many lack the resources to monitor it appropriately.

In addition, at present no clear reward exists for preregistration besides the transparency badges, which are not used broadly in biomedical journals. Preregistration is also not integrated into the peer-review system. To boost the uptake of this method, new incentives must be created and researchers should be held accountable. Therefore, the need for a standard procedure to monitor and enforce preregistration across Dutch (and European) funders will be needed in the future for this method to enter regular research workflow.

> *"I think if journals were to request it, people would just go to another journal that didn't request it because they probably haven't pre-registered most of their research." – PSJ40*

> *"I'm not convinced that it will go with these voluntary approaches, not as I know my scientists." – PSJ94*

Table 3: Factors encouraging and discouraging preregistration use, and potential improvements according to surveyed participants

Encouraging factors	Discouraging factors	Potential improvements for Dutch funders
1) Guidance & Support 2) Explanation of benefits and/or proof of impact 3) Reward	1) Lack of time/workload 2) Idea theft 3) Lack of training/fear of animal activists	1) Add information on their website/provide more guidance 2) Increase user-friendliness e.g. make it easier by linking it to CCD application or work protocol 3) Align with international funders on one platform

Box 1 : Preregistration Summary

- Preregistration is a valuable method that is still developing, and hence only a few stakeholders facilitate and support it at the moment. Researchers see the value but find the methods too administration heavy and lack guidance.
- Preregistration should be demanded for applied and confirmatory research first.
- More efforts are needed to increase awareness and ease of use before it can become part of the regular research workflow.

Recommendations

- Dutch funding organisations subsidising animal research should consider making preregistration of animal studies for large preclinical trials mandatory (i.e. trials preceding clinical trials).
- Dutch funders are advised to discuss with each other on: 1) what type of reward (or sanction) to give for (lack of) compliance with preregistration, 2) how and when to monitor preregistration in a similar fashion. In each case, broad alignment between funders policies are recommended.
- Universities, license holders and animal welfare bodies ought to promote preregistration to university courses (e.g. Article 9, science integrity, the curriculum in general) and the information provided to the researcher (e.g. add information to the instructions/protocols or website).

7. DMPs and FAIR Data

At its core, research involves the generation and collection of data to evaluate hypotheses and concepts, thereby making data fundamental to the essence of science. It is therefore not surprising that the management of data, from its generation and handling to its sharing and archiving requires an intricate network. Indeed, research organisations need a panel of skills, knowledge, and infrastructure to efficiently handle each phase related to data, which requires manpower, expertise, structure, and resources (Jetten et al. 2021). The implementation of data management planning and data management plans (DMP) and FAIRification of data fall under this overarching structure. This requires the involvement of data stewards and research software engineers, who can facilitate this and stimulate academia in the development towards FAIR data and open and sustainable software. However, it has become clear that there is a large need for, and shortage of, individuals with Open Science and data stewardship expertise within research organisations. This is felt in all research domains, including projects involving animal research, and also transcends the institutional and even the national level. Thus far, there is no universal structure in which the management of research data is organized in research organizations, although important steps have been made, including a Dutch roadmap towards national implementation of FAIR data stewardship by the National Program Open Science.

Currently, in terms of organization, most data stewards are affiliated with either a general centre or a digital competence centre, often supplemented by other teams or, occasionally, by the university library. If there are multiple data steward teams within a research organization, for instance in different faculties, they are often interconnected and linked with other teams responsible for infrastructure (IT/ICT), intellectual property, or GDPR compliance (PSdata04). This interconnectedness forms a '*heterogeneous network*' providing a wide array of skills both within and across institutes (PSdata27). Data stewards and institutes learn from and connect with each other through various avenues, including Open Science communities, consortia, coordination centres (such as Health-RI), specialized institutes (like DANS), and the utilization of common infrastructure and training (such as existing repositories like dataverseNL, the platform Research Data Netherlands or the Thematic Digital Competence Centres). Other important networks of data professionals are The National Coordination Point Research Data Management (LCRDM), the Data Steward Interest Group (DSIG) and the 4TU.ResearchData Community.

In general, the research data management network of a research organization is aimed at providing researchers with the proper support and training to create their DMP and that each team can address specific needs. However, this is not always working optimally. The complexity of the system is due to the fact that, unlike the ARRIVE guidelines or open-access publishing, research data management demands extensive skills, often beyond the capacity of individual researchers, in addition to specific standards and specificities for

each field. (Of note: data management is currently applied to all research areas, not just animal research, which thereby ensures a more extensive support system.) Finally, there is almost no training in place for FAIR, which makes it difficult to have uniform policies on the implementation of FAIR.
We explain below how data management networks operate in practice, including the feedback from the researchers, requirements and monitoring for DMP and FAIR, the available resources for researchers and stewards, and potential improvements suggested by the surveyed participants and interviewees. However, it should be noted that there was no definition of FAIR shared with the researchers or interviewees before questioning them and that the level of understanding of what FAIR is, was not taken into consideration.

Out of the five investigated methods, FAIRification of data (n=29 out of 32) was one of the methods that most respondents had heard about. However, less than half had designed a DMP in the past in order to make data FAIR (Figure 8). FAIR was perceived as a method that could improve transparency (n=9/9), reliability (n=8/9), impact (n=6/9) and quality (n=5/9) of research (Figure 9). Surveyed participants found DMPs rather useful (more than half disagreed with the statement of DMPs being unnecessary) and agreed that it would add to the FAIRness of results (n=15/22). Despite the majority thinking DMPs are not unnecessary, most participants were not fully convinced of their necessity either, painting a mixed picture (n=9/22 disagreed on the necessity and n=7/22 did not have an opinion). Most participants however, agreed on the usefulness of FAIR for others (n=7/9) and themselves (n=5/9).

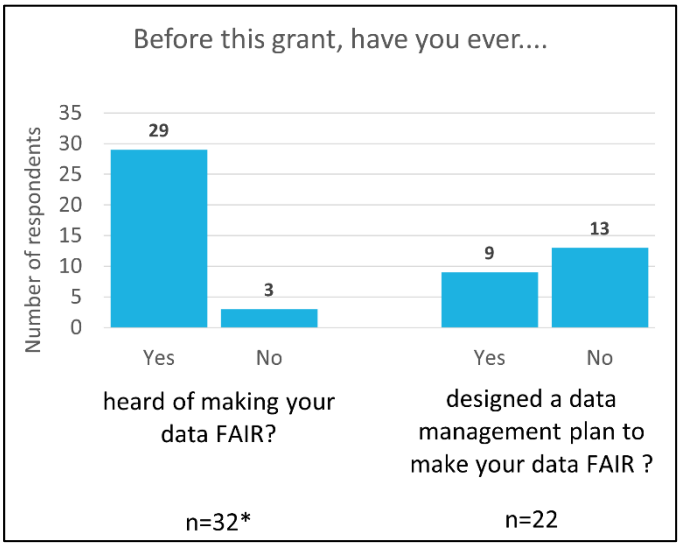

Figure 8: Awareness and previous use of FAIR (n=32) and DMPs (n=22).
**FAIR: these numbers combine both the questions asked about FAIR in the study design survey and the FAIR survey, hence the higher number of responses.*

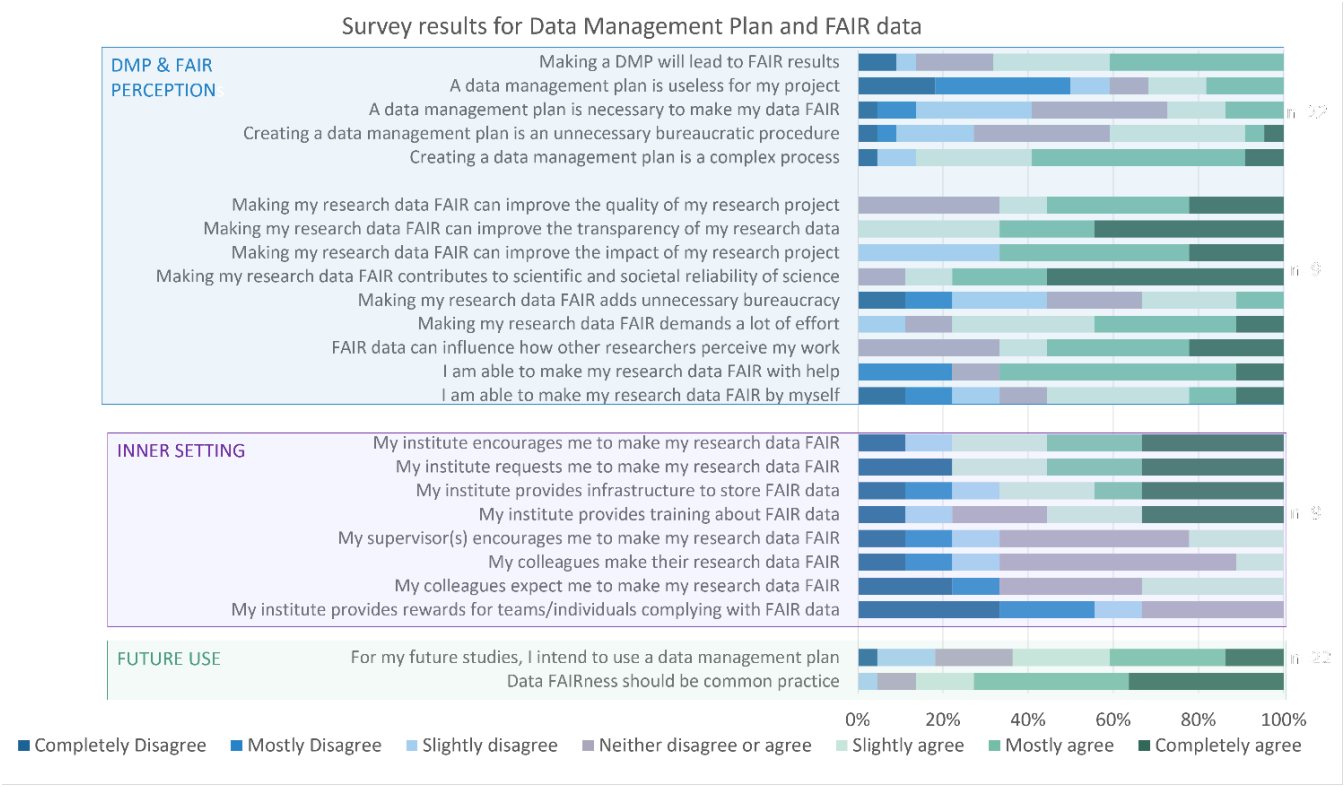

Figure 9: Survey results for Data Management Plan and FAIR data

Data stewards reported that most researchers are open to DMPs and data sharing/FAIR principles, but that some resistance existed, especially with the more senior researchers (PSdata27, PSdata32, PSdata80, PSdata95) and that some even refuse to be trained (PSF57). Stewards recognise that this resistance can be warranted, as they transcribe valid concerns, which should be heard and addressed appropriately (PSdata80, PSdata95, PSdata88). This feeling was also shared amongst funders (PSF38, PSF57). Nevertheless, in rare cases, some of these concerns, although relevant, were referred to as "*clever excuses*" to not change the status quo (PSdata88).

> *"I know there are reservations. Sometimes those reservations are also warranted [...] And that can become a problem if those people are not heard. If somebody has some valid concerns or some valid reservations with some parts of the Open Science policy or FAIR principles, if you just tell them 'you're wrong, my opinion is the correct one and you just have to do what we say', that is just going to create more and more resistance and that can really become an issue." - PSdata95*

Resistance often appears to stem from a lack of perceived benefits and the infrequent reuse of data; researchers perceive minimal value in investing time to make their data reusable if there's little likelihood of it being reused. They wonder "*what's in it for me*" but also "*what's in for the reuser*" (PSdata27). It seems logical to first show the researchers why these methods are important and what they can gain from them. From the survey

results, we also see that a minority of the participants felt encouraged by their supervisors to make their data FAIR (n=2/9 slightly agree).

> *"For many researchers, it's perceived as red tape; something that they need to do, that they might not find useful for themselves". – PSF57*

Regarding reuse, several factors seem to contribute to this low uptake rate according to interviewees:

1. Researchers distrust what is generated by others (PSdata27);
2. Concerns about potential mistakes being discovered when someone reuses their data (PSD16);
3. Perceptions that studies reusing data are less impactful;
4. Fear of being scooped if they share their data (PSIvD03, PSIvD55, PSD16, PSF05, PSF14).

Moreover, some researchers seem to see the transparency methods as something they must do, but not as relevant to them (PSF05, PSF57). Resistance also arises from the lack of studies showing the positive effect of creating a DMP or making data FAIRer (PSdata80). The promotion of existing studies (PSF05), but also the design and execution of new meta-research studies on the transparency methods should be done (and could be supported by funders (PSdata88)).

> *"Eventually, we do need to show them that what they're doing is actually achieving results in terms of better process, reproducibility or better transparency or better science or better recognition. And I think the more years that go by that we don't study this, that we don't generate some sort of reports on this. Then the more people are going to be doing 'well, you've been telling me to do this for so long and nothing's changed." PSdata80*

> *"You have also the ones that actively kind of like discourage it. And if you have that kind of environment and that you as a PhD student, only rely on your own intrinsic motivation to do it, but you're not being helped with that at all. That's detrimental to the whole process because then they're not going to do it because otherwise it means getting into conflicts, getting into discussions with everybody, you're accused of wasting your time on things. That's where Open Science and your principles completely come to a stop".- PSdata95*

In terms of application, DMPs and FAIRification/making data reusable were perceived as complex processes for most surveyed participants, but only mildly as an administrative burden. In particular, data format and standards (n=12/22), finding appropriate registries/databases to share data (n=11/22), making datasets machine-readable (n=10/22), and metadata/metadata standards (n=7/22) were considered as difficult aspects of FAIR data. Data stewards' answers emphasise these hurdles, and added as well that researchers face difficulties mostly with interoperability, filling in their DMP, documentation, ontologies, and ways to enter data in proper formats compliant with FAIR. Positively though, participants expressed that they felt able to make their data FAIR/reusable with someone's help (n=6/9), or even alone (n=5/9).

Hopefully, to help them further, researchers can benefit from personalised guidance. In practice, researchers reach out to stewards either through a ticket system or directly via email (central n=15/22, local team n=5/22; Figure 9). In our surveys, many respondents reported that they received information on the infrastructure used by their institute to store data and/or on how to store data in general (n=6/9). Besides guidance, various tools and training are also available within research organisations. General awareness about data management and FAIR is typically made via the organisations' websites, and other documents (e.g. overview flyer about all storage system (PSdata04)). Half of the surveyed participants could receive documentation from their data stewards. Nonetheless, improvements on the promotion could be made (PSdata27, PSdata88). In addition, multiple courses and workshops are available, offering general instruction either in-person, online, or both, occasionally including hands-on activities. A third of the surveyed participants said they could benefit from these (n=7/22). Some courses focus on specific research data management topics such as metadata and documentation. Additionally, there are courses tailored to particular tools, software, or infrastructure like digital environments, storage systems, Git, R, etc. Certain courses feature "meet the experts" sessions (e.g. PSdata27, PSdata95). Courses are usually designed for PhD students and more senior researchers, but courses open to Bachelor's and Master's students are also in place. Some courses are mandatory as soon as new workers start at the research organisation, e.g. (PhD) introduction days (PSdata27, PSdata95) to facilitate common knowledge and understanding of the process for all employees. It is also important to note that general courses might need to be repeated as people might have forgotten about them by the time they need this knowledge (PSdata95). Some organisations also have "leave protocols", to make sure researchers' data remain accessible after they leave their job positions (PSdata95). However, both entry and leave protocols have not yet been implemented everywhere. For the future, it is important to recognize that new courses can be initiated by the steward teams (PSdata32, PSdata52, PSdata80) and some institutes even have working groups to put this into place.

Despites the plurality of support, surveyed participants provided more nuanced and institute-dependent answers when asked about the informativeness and usefulness provided to design their DMPs. On one hand, positive feedback was given *"I found the support of the data manager extremely useful. Without the help of this person, it would have been difficult to complete." (ID156529074)*. On the other hand, flaws were also mentioned regarding the availability of the data stewards, the quality of the guidance and the format of the DMP documentation, as expressed by the following quotes:

> "*Because the data management support is organised across the institution, the support is very general and no specific support for my case is provided"* - ID142658181

"The staff in charge of the DMPs are overwhelmed. There is a single data steward for a huge organization; this should be managed department-wise. The requirements and needs are very different and depend a lot on the lines of research of the department." - ID129946789

Through this study, we also highlighted a difference in tools and platforms used by the different research organisations. For instance, for the DMPs, four stewards stated that their organisation use DMPOnline, a web-based tool whose template is accepted by ZonMw and NWO, while the two others used another web tool and Word templates. Feedback can be asked via DMPOnline, which is also how researchers easily receive assistance. To note, a data steward pointed out that their DMP template is primarily human-focused (PSdata52). Although they mentioned that a preclinical checklist is used as an addendum to the template, it is only provided in consultation. One of the research interviewees, from the same institute, reported the difficulty of using this template and was not aware of the preclinical checklist. This underscores the potential need for refining templates related to preclinical studies and promoting consistency across institutes, for instance by stimulating a nation-wide coordination on what is minimally required.

> *"I only got a template from research support and 'good luck'. That was it [...] a lot of these standard things in the templates were all based on data collection from patients. So yeah, it was not convenient and I really had to find a spot within the template to put my specific sequencing animal kind of data in there. " - PS91*

This lack of alignment and overwhelming feeling that surveyed participants mentioned was also found back in the data stewards interviews. Indeed, when questioned about their roles and the support they receive, data stewards expressed overall satisfaction, but also indicated that there is room for improvement. This is mostly with regard to the development of data management practices and the growing demand for their help. Indeed, stewards from central and local teams see that they would benefit from additional local and embedded data stewards (PSdata27, PSdata32, PSdata95), both to spread the workload and make "*communication lines short*" (PSdata95).

> *"So nowadays it takes a lot of my time because there are not enough local data stewards. [...] We have now about 2/3 of the departments covered with a person, either a full blown person or just a data steward as a whole. So we still have 1/3 to go and we still have to work on those people who don't have an actual function and to support them more and to have the budgets assigned to them." – PSdata27*

> *"So I think the work is now doable, because maybe some people don't even know that we exist yet [laugh]. And if these people know that we exist, then it might be too, too much work, yeah." – PSdata32*

Another point raised by data stewards was their supervision and onboarding. In general, no clear implementation plan was given to them to apply institutional policy, and most stated that they had to be flexible in their job.

"when I started like a year ago, it was really open, 'you're now data steward then, do your data steward things, ok?'. I found it very difficult, I think I needed a half year to really adjust to my job. [...] a little bit more explanation, a little bit less 'OK, do your job and good luck. Go to the faculty'.. hum, OK? – PSdata32

Besides sometimes lacking general clear guidelines, data stewardship also demands a *"learning curve"* to adjust to this load of information and specificities. It will take knowledge and experience to know what to advise for which type of data, which team to reach out to (both inside and outside an organisation), and the law related to the data (e.g., to intellectual property, GDPR) (PSdata04). In that regard, data stewards and support staff can take courses to broaden their knowledge and better support researchers (PSdata32). Furthermore, FAIR develops fasts and it is difficult for the data stewards to stay on top of everything.

Another crucial point in the implementation of proper data management appears to be institutional structure, culture and policies, both for the researchers and the data stewards (PSdata95, PSD17). All data stewards and some deans mentioned institutional policies, directives and/or research codes for Open Sciences that are in place in their research organisations. Some even stated that DMPs are mandatory before each study (PSdata 04, PSdata32). Many of these policies had recent modifications to accommodate Open Science practices more, and therefore not all methods are currently fully implemented. In these cases, they come closer to "*things the institute would like to do*", and hence methods are not monitored and can easily be circumvented (PSdata27). Creating a clear policy with an implementation plan is a great way to ensure the uptake and the aligned involvement of all necessary teams. However, *"not all universities are at the same level"* (PSdata95), and *"no one has covered everything"*. Regarding other stakeholders, DMPs are demanded by most funders. Some additional information regarding DMP are also demanded for some of the stakeholders (PSF16, PSF61), and are checked either at the beginning of the project, or during the progress- and end- evaluation.

Most funders also mentioned that changes are ongoing for their Open Science policies and that progress is being made to align them with other funders (PSF38, PSF61). This is in line with the **recent funder declaration** of ZonMw, KWF and Health~Holland to strongly collaborate with Health RI on a national data infrastructure. In light of this, exploring how research organisations can harmonize their practices with evolving funder requirements becomes imperative, especially given the potential overlap in inquiries. Furthermore, it would be relevant to assess how research organisations can align with existing funder requirements, as they might ask similar questions.
For ZonMw/NWO funding it is already mandatory for a researcher to consult a data steward for the DMP, who also has to sign off on it. To ensure that the requirements concerning data management are met, some monitoring is done by data stewards, either for DMP or to

ensure that all information is present and complete before uploading/sharing/archiving data. However, the depth of the monitoring differs per institution and is not automatic for each study; most important in this respect is that the funders accept it. In that regard, some data stewards do appreciate enforcement by funders, as they note the positive effects (PSdata04, PSdata27, PSdata32, PSdata95, PSdata88); one even mentioned that monitoring by funders could be even more strict (PSdata95). At the same time, it's worth noting that if data stewards would need to personally check every DMP or to facilitate full FAIRification for all researchers, there wouldn't be sufficient staff to perform such monitoring (PSdata52, PSdata95).

> *"If a researcher can do it (the DMP) themselves, he/she doesn't have to consult us and it's not mandatory to get our approval or whatever from us." – PSdata52*

When it came to future plans to improve the implementation of DMPs and FAIR, participants suggested some changes. Surveyed participants also provided encouraging/discouraging factors and potential improvements Dutch funders could make (Table 4).

Table 4: Factors encouraging and discouraging DMP and FAIR data use, and potential improvements according to surveyed participants

Encouraging factors	Discouraging factors	Potential improvements for Dutch funders
1) Guidance & Support 2) Training 3) Improve easiness of use 4) Institute/Funder value methods + reward 5) Proof of usefulness	1) Complexity & lack of resources/time 2) Lack of guidance, training, expertise or encouragement 3) Not tailored to specific fields of research 4) Lack of sufficient number of data stewards (embedded/ decentral)	1) Stimulate training and uptake by research institutes, notably by convincing 'higher ups' or by providing funding.

Align awareness, promote evidence and support

Currently, many researchers struggle with DMPs and FAIR data, or see little advantage to applying it for themselves (as shown in the survey results). To ensure a sustainable uptake, researchers must realise what the benefits for them are. This can be acquired via discussions with data stewards, courses, or by seeing studies on the topic. The current course system differs per institute - installing an "entry protocol", like it is done in some institutes, could help provide an entry level to all researchers. Alternatively, adding the topic of research data management as mandatory PhD courses could also help. Dutch research organisations could learn from each other regarding their respective course

catalogue and their entry protocol to avoid reinventing the wheel, while effectively aligning on their awareness-raising strategy; of interest here is the training & teaching platform Taxila. Moreover, conducting additional studies assessing the effect of transparency methods on research quality, transparency and/or impact would support their further implementation. These studies could be brought back in courses to motivate researchers.

Lastly, researchers require help from data stewards to comply with the DMP and FAIR requirements. However, some researchers have trouble finding the right person. One data steward mentioned that their organisation put someone in charge of communication to improve that aspect (PSdata27). With the number of embedding data stewards hopefully increasing with the years, a better overview of roles and responsibilities would be beneficial.

Facilitate the process and aligning requirements

As seen in the interview, each research organisation uses different tools and infrastructure when it comes to DMP and FAIRification of data. Reaching national alignment on the entire process will be difficult to achieve, however, trying to avoid redundancy across stakeholders, for instance by comparing the number of different DMP-templates and tools, and aligning existing tools/information demanded for animal studies, may be more realistic. It could also help to more easily exchange data across Dutch institutes and also highlight the needs for discipline specific data management. Funders may contribute in this, which is exemplified by the initiative of ZonMw and NWO to make agreements with several research institutes about acknowledgement of their institutional DMP-templates by adopting unified questions, and provide advice on data management. Project leaders may use these for writing the DMP for their ZonMw- or NWO-funded project, which is a big step forward in coordinating the use of DMP templates.

Within organisations themselves, participants told us that little guidance was given when it came to “how to support and guide researchers”. Per institute, local and embedded stewards could align here on their advice to prevent unnecessary discrepancies. Long term, this could be done between central and local teams, which would require institutional protocols that describe domain-specific and local guidelines, tools, infrastructure and support.

Create recognition and rewards for DMPs and FAIR, but also monitor them

As mentioned for other methods, the integration of transparency methods into the reward and recognition system is needed to incentivise researchers to comply (PSdata80, PSdata04, PSdata52, PSF57). Setting such indicators in future assessments (e.g. grant assessment, job positions) would, in theory, stimulate researchers to engage with them more. However, more recognition also goes in hand with a stricter monitoring, which at present is difficult to put into place.

Create value for the data steward jobs

The involvement of embedded data stewards is key to ensure short communication from researchers to support staff, and ensure field-specific advice. Therefore, more incentives are required, such as more means for these part-time positions (PSdata 27), better career perspective and more guidance. Emphasising on such (hybrid) position already at Master's level could also help re-evaluate the position of data steward as crucial within the research chain, instead of "support staff".

> *"We have noticed that researchers need more support in organizing their research. They need assistance, and we should make it as easy as possible while offering career opportunities for those who may not want to pursue further research but have roles as data stewards, for example. This entails hybrid careers for information specialists, ethical experts, or data professionals." - PSD12*

Box 2 : DMP & FAIR

- Good data management requires an intricate network of personnel, software, tools and infrastructure, which also comes with its own standards, resources, and skills. Different courses and means of support are already in place to help researchers.
- Due to the complexity of the field, it would be beneficial to have a better overview and clear guidelines for both general and field-specific stewards and resources.
- Next steps for long term implementation are: 1) integration of the methods in assessment (recognition/rewards), 2) alignment on tools amongst and between institutes and funders to facilitate the process, and 3) provide basic knowledge for all researchers on DMP and FAIR.

Recommendations

- Funders could assess differences and similarities between the information they demand in terms of DMP and FAIR requirements for animal studies to avoid redundancy. Together with UNL & NFU, they could investigate the content of DMP templates used by research organisations to achieve greater alignment between what institutes and what funders ask and highlight needs for discipline-specific demands.
- Open science communities should discuss with their board of directors and deans on including the adherence to transparency methods to the evaluation and recognition of researchers.
- Deans and the board of directors, in cooperation with their integrity centre or digital competence centres, should consider the possibility of adding an "entry protocol" around data management for PhDs and new employees.

8. ARRIVE guidelines

For the few participants of the ARRIVE survey, most have used the guidelines before (Figure 10). They all perceived the usefulness of the guidelines and found them beneficial for their project (n=3/3) (Figure 11). However, they were more nuanced on the complexity of applying them and in the support/encouragement they have received in their institutes. Time and lack of knowledge were mentioned as discouraging factors by the surveyed participants. Positively, they all mentioned that they would recommend ARRIVE to their peers and use the guidelines in the future. Due to the low number of answers, it is difficult to draw strong conclusions from this.

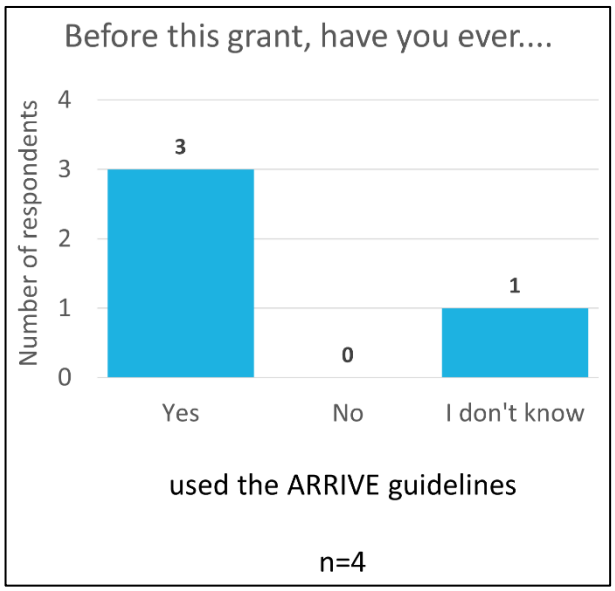

Figure 10: transparency methods awareness and previous usage
There was no question on whether the participants had 'heard about ARRIVE'.

Most interviewees knew about the ARRIVE Guidelines, particularly the journal editors, and overall recommended their use. They mentioned that these guidelines are recommended in three of their journals and mandatory in one. Indeed, the ARRIVE guidelines were qualified by one of the editors as the "*bare minimum of what scientific reporting has to be in order to be reliable, reusable and retested*" (PSJ87). Within the funder group, six mentioned either a recommendation or requirement to apply ARRIVE in existing grant schemes. ARRIVE is also encouraged by animal welfare bodies and is even integrated as part of the research plan for some of them (PSIvD40).

> *"When it comes to laboratory animal research specifically, I think it's best to enforce some more pre-registration and ARRIVE Guidelines and that it's monitored as well." – PSD16*

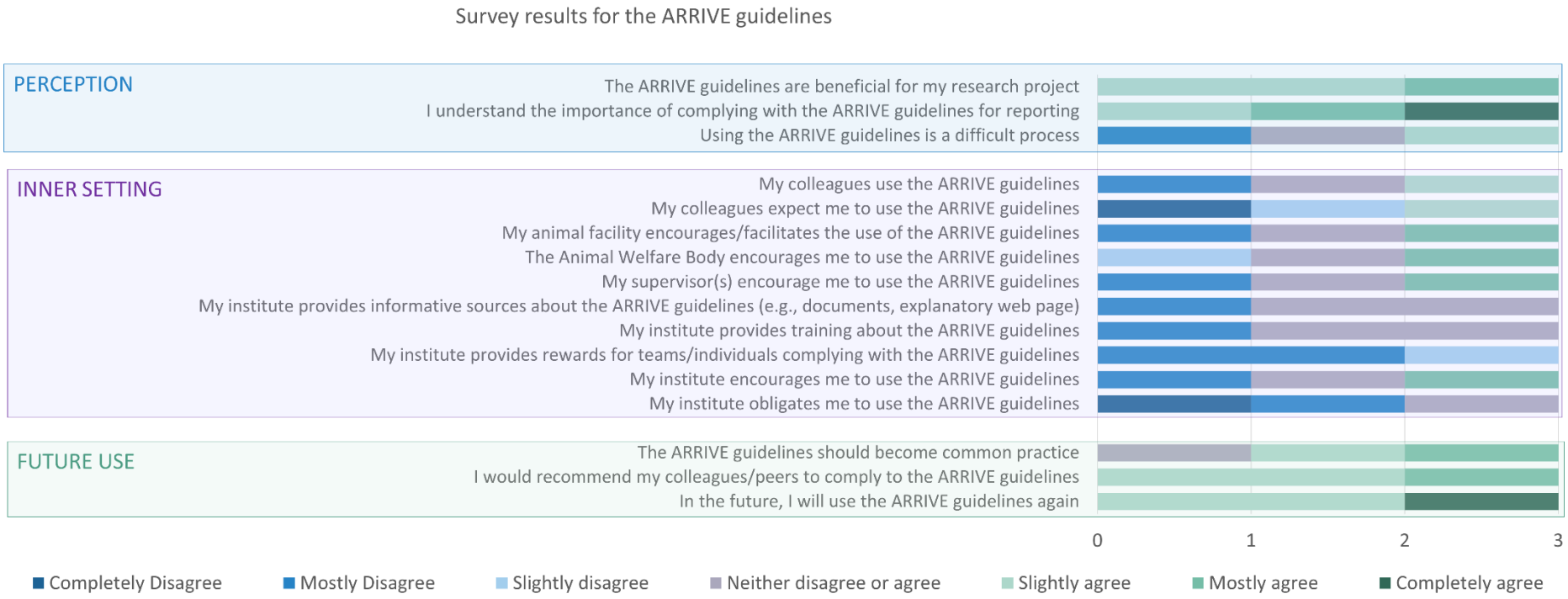

Figure 11: Survey results for ARRIVE guidelines

Despite being established in 2009 and receiving endorsements from numerous biomedical journals, the ARRIVE guidelines face challenges in practical implementation within the research workflow (Leung et al., 2018, Hair et al., 2019). Indeed, also from this survey it is clear that a potential factor contributing to this difficulty is a lack of training and awareness, as a significant number of invited participants had "*no experience with ARRIVE*" or only limited skills in applying the guidelines, despite the diverse target population. This was supported by the few survey answers.

> *"I see that the guidelines exist, but I do observe that relatively few researchers actively engage with them. [...] Researchers are not concerned with them because of the guidelines themselves, but rather because they need approval for their experiments." – PSIvD40*

Another contributing factor to the limited implementation of ARRIVE guidelines is the constrained space and word limitations imposed by journals. Journal editors acknowledged the persistence of word restrictions in the field, although they also recognised ongoing improvements. Existing solutions would be excluding the method section from the word count (PSJ87), or incorporating the protocol into a repository and referencing it within the article (PSJ40). Research organisations could also stimulate making methods more accessible (PSD12).

Furthermore, monitoring of the guidelines plays an essential role in their integration. Even though the ARRIVE guidelines are encouraged, their monitoring demands skills and time, which most stakeholders can't afford (PSJ04, PSJ40, PSJ87). Journal editors commonly delegate this responsibility to section editors, provided they possess the necessary skills, or to peer reviewers. However, during our interviews, only one editor discussed conducting a thorough examination, while others mentioned more superficial checks, such as confirming the presence of the checklist without delving into its content. Other stakeholders also expressed concerns about these "soft" requirements lacking robust enforcement. (PSIvD40, PSIvD72).

> *I think this is one of the barriers to implementation generally across publishers, we don't have the resources to actually police that everything in the ARRIVE guidelines is actually done as the guidelines suggest. – PSJ40*

> *"Make sure that the quality of your papers lives up to the standards. And that last part is still difficult because journals don't require that you live up to the PREPARE guidelines and the ARRIVE guidelines. Well, maybe they say that they advise it. But they do not demand. They do not ask any proof for this" – PSIvD72*

Monitoring conducted by other stakeholders faces similar challenges, but is exacerbated by the lack of effective methods to enforce compliance. Finding a middle ground is challenging, as imposing consequences that are too severe might demotivate researchers. For instance, impacting subsequent research protocol procedures for animal welfare bodies or withholding a portion of grant money by funders could be considered overly stringent. Given these circumstances, implementing incentives and rewards, akin to approaches used in other methodologies like preregistration, may represent a more viable path forward.

> *"It is difficult to control at the moment because often, when the research is complete, the publication may come out much later, even two years later, and we often have no visibility over that. If we wanted to control it, we would have to set it up in such a way that we say, 'Yes, you can only submit your next work protocol after we have received the publication in advance' but the timelines are different, and we can't do that. – PSIvD37*

These results show that improvements are needed before ARRIVE will become standard practice. Several solutions should be explored, namely 1) changing the monitoring process, 2) increasing awareness and training, and 3) making the application easier.

Stakeholders must be held accountable and start monitoring strictly and with more consequences. To facilitate efficient ARRIVE scoring, monitoring could be streamlined through tools; presently, there are no tools that comprehensively and automatically address all ARRIVE items. Nonetheless, ongoing developments in algorithms and AI by the ScreenIT consortium are underway, enabling the identification of incomplete or lacking information. The ARRIVE guidelines themselves have already been simplified with the introduction of ARRIVE 2.0 and the creation of 'The Essential 10'. In line with this trend, stakeholders may choose to concentrate solely on these 10 items instead of the entire set. It is also possible that part of this set is already asked for by funders or editors (e.g. regarding ethical practices); specific recommendations on how funders can use and promote the ARRIVE guidelines is given on the ARRIVE website.

Important issue is how compliance to using these guidelines can be monitored; when done manually, the ARRIVE compliance questionnaire can be used. Interestingly, assessing ARRIVE compliance will in the near future be facilitated by a freely available, AI-based tool that can streamline manuscript checks to ensure that animal research is transparently reported in line with ARRIVE Essential 10 (expected in 2025).

Lastly, another solution to simplify compliance may be to use existing research protocols (which often follow ARRIVE essential 10) to create the method section or use existing animal welfare body software to (partially) generate method sections via an algorithm. However, for this process to operate effectively, it would necessitate 1) checking that the protocols align with ARRIVE 2.0 and 2) creating alignment among all animal welfare bodies regarding the content of their research protocols.

Box 3 : ARRIVE guidelines

- ARRIVE are endorsed and recommended by most stakeholders, but not strictly monitored; combined with words restrictions and lack of additional awareness, encouragement and skills lead to an overall low implementation.
- To improve ARRIVE uptake, monitoring must be changed and guidelines application facilitate.

Recommendations

- Dutch funders are advised to discuss with each other on: 1) what the type of reward (or sanction) to give for (lack of) compliance with ARRIVE, 2) discuss which existing tools or information to use to monitor ARRIVE and 3) decide if they apply in requirement the “Essential 10” or the whole ARRIVE set. In each case, broad alignment between funders policies are recommended.
- Animal welfare bodies may verify that research protocols comply with ARRIVE and see how to ensure aligning of content to allow automated method section generation.
- Journal editors/publishers could stimulate within their journals to implement and monitor on the ARRIVE guidelines.

9. Open Access Publishing and data sharing

Open access publication was the method best known by respondents (n=20 out of 20) (Figure 12). A majority have shared their research data (n=18 out of 22) and have published Open Access (n=18 out of 20) prior to receiving their grant (additional information on what they shared in Appendix S5).

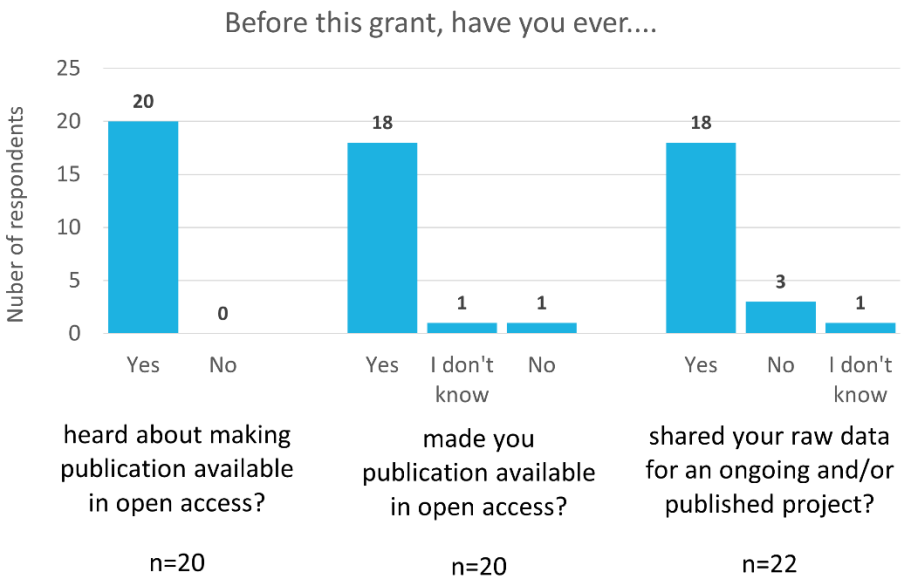

Figure 12: Awareness and previous use of Open Access Publishing

This is probably linked to the fact that Open Access Publishing is also a method already in place within most research workflows. All funders interviewed encourage or require Open Access (NWO since 2015), and see that the uptake is working well - two funders referred to 85% of granted projects published Open Access (PSF21, PSF57). (Of note: the NWO and ZonMw Open Access Monitor 2022 indicates that 93% of the publications in 2022 from research funded by NWO and ZonMw have been made available Open Access.) Several funders also referred that they are part of "cOAlition S," an international consortium supporting the "Plan S" initiative to make all scholarly publications published Open Access or deposited in Open Access repositories (since 2021). Funders also recommend data sharing (when possible), and request for several grant schemes that researchers make all their research outputs (e.g. article, dataset, code etc) openly accessible, as much as possible. Most interviewed journal editors (and publisher) worked for open access journals. Regardless, data sharing was recommended in all journals, and code sharing was recommended in one of them. Journal editors sometimes publish editorials on data sharing to increase awareness (PS94).

Survey respondents were aligned with this ambient Open Access movement. Indeed, when asked about the most important features of a journal for publication of their work, respondents included:

1. the visibility and dissemination of their work,
2. prestigious/high impact factor journals,
3. journals that have a clear submission system, with a transparent and constructive peer review process,
4. that quality is put before quantity and speed.

They perceived Open Access publishing mostly as useful and to have a positive impact on dissemination (n=15/19) (Figure 13). Most participants did not perceive Open Access publishing as of lesser quality than traditional publishing (n=12/19). However, most participants (n=15/19) found the methods too costly. Surveyed participants felt encouraged to publish Open Access (n=12/19) or make their publication available (n=9/19), but received little support from their institute. Indeed, they indicated that their institute focuses primarily on the impact factors of the journals (n=17/19) and the number of published articles (n=13/19), rather than the openness of the journals. In addition, more than half reported that their institutes do not cover the required publication fees (n=11/19). The quality of the open access journals was also a worry for some participants.

On the interviewees side, the biggest perceived barrier to Open Access publishing was also financial support to pay the article processing fees (APCs). Participants mentioned that their research organisations or the ones they collaborate with usually have either contracts or licenses with publishers to reduce or remove the publication fee. Some funders cover (partial) APCs, but not all of them have such options in their grants. Unfortunately, these solutions do not truly solve the root of the problem, but only circumvent it. Many commercial publishers seem to regard APCs as lucrative revenue model and have no reason to stop this profitable endeavour.

This lack of openness on how the APCs are calculated and used, raises concern and brings about a lack of trust in open access publishers, although not all publishers are comparable in that aspect (PSJ04). But why do research organisations keep closing expensive contracts, supporting companies with public money? One of the journal editors mentioned “prestige” as leading factor, and how universities “need to be able to publish with them in order to maintain ranking as a Tier 1 research university” (PSJ87). Unhappily, editors themselves seem to have little say in the fees (PSJ94), but they did state their dissatisfaction of their publisher on this topic (PSJ40) or the wish to move to other business models (PSJ04).

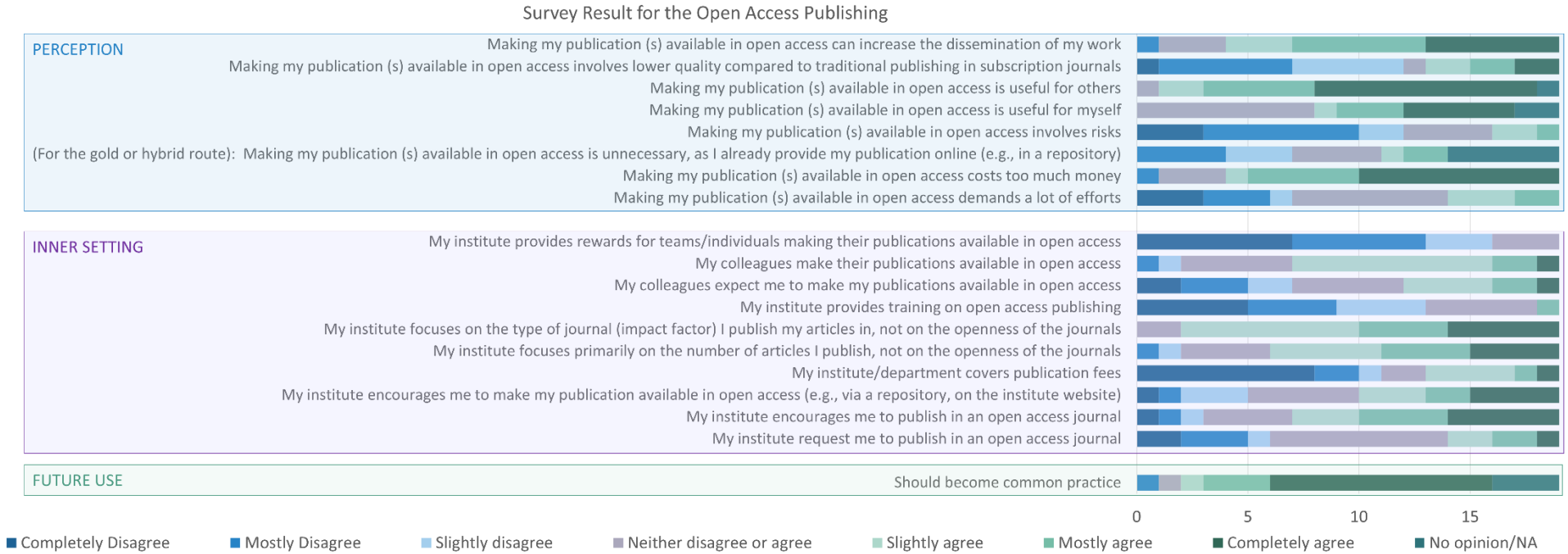

Figure 13: Survey results for Open Access Publishing

Participants in other stakeholder groups also mentioned their dissatisfaction with the APCs and the dependence of research organisations on publishers. They also pointed out to the illogic of publishers handling the price of contracts and APCs seemingly at will, without a transparent basis, and supported by the notion that "your researchers would like to be in our journals" (PSD47); this practice was referred to as "*Madness!*" and "*a completely messed up system*" (PSdata95). Another interviewee even said that publishers are "*exploitative*" (PSJ87), and gave the example of the "Pure" platform belonging to Elsevier - a repository used by some Dutch Universities, but that requires them to pay Elsevier for its management.

> *"As we increasingly become reliant on research management systems that come bundled in these read and publish things, we are just going to further kind of contaminate the university systems and become further reliant on these, for profit publishers who are using taxpayer money and exploiting researchers". - PSJ87*

Moreover, most people interviewed agreed that publishing negative data was also an issue and a difficult exercise (PSD100, PSD47, PSF05, PSJ94). This is something that ZonMw has been promoting for several years in the More Knowledge with Fewer Animals (MKMD) program, in which funding is available to help researchers publish their negative data; but even this grant scheme is not used to its full extent, suggesting that time rather than money is withholding researchers to publish negative animal data. Participants agreed that improvements to share all data are required. Although it's growing, data sharing, defined as either making the description of the dataset and the data set itself available to others under conditions that can be set by the original researcher, is still not commonly recommended or highly valued across publishers (PSJ40).

The integration of Open Access and data sharing within recognition and rewards was also raised in this topic. Most journal editors had an opinion on transparency badges, and one mentioned the use of 'badge-like" element in their journal (e.g. accessibility badge (PSJ40)). However, two editors were sceptical of these reward badges; one about their efficacy (PSJ04), and the other about the "gamification" of science around these new metrics (PSJ87).

Lastly, although Open Science is quite promoted (with requirements and means), there are currently no strict checks to verify compliance for each publication on Open Access and data sharing, but only general checks. For instance, in the case of funders, if a grantee does not comply with requirements, it won't necessarily lead to sanctions; most funders will first start a discussion on the reasons behind the lack of compliance. The feedback on funder monitoring was nuanced; monetary sanctions for one article not being published Open Access could be seen as *"heavy-handed"* (PSF97), while some others thought it could motivate researchers to comply (PSD100).

Limited information was provided regarding the monitoring of data sharing by journal editors, except for the inclusion of data availability statement in their submission form (PSJ94); yet the content of the submitted data is generally not checked. Data stewards also mentioned that more enforcement by journals would be beneficial for compliance (PSdata32, PSdata80, PSdata95), although current efforts to mandate data sharing were also acknowledged (PSdata04 & PSdata95). Animal welfare body members reflected on Open Access policies, and while they support it, they are not in the position to act on it themselves (PSIvD55). Nevertheless, depending on their mandate, AWBs could suggest new policies on this topic to the license holder.

To better improve the implementation of Open Access and data sharing, the participants mentioned several interesting ideas:

Leave the commercial publisher-contract system

Creating a new system where the publishers hold less power could be a fruitful option, and might redistribute the power given and attributed to "publications" as a research output. Some diamond Open Access platforms/journals are starting to emerge (i.e. journals/platforms not requesting any APCs). Generally, these initiatives are community-driven and academic-owned publishing initiatives and are by essence more accessible and equitable than those in the current commercial system. An interesting Dutch initiative is the NWO-funded platform Openjournals.nl. Yet, phasing out commercial publishing is not trivial (for instance because of competitiveness, when researchers from other countries can still publish in commercial high-impact journals) and requires a cultural shift from the current norm.

Increase recognition and reward for Open Access publishing and data sharing, and facilitate the process

Looking beyond the publication as main research output in assessment, recognition and reward could be a first step to a better implementation. Other research outputs, such as dataset or code, are perceived as *"low priorities"* (PSJ04). It remains to be seen how to *"rebalance the credit"* to make the extra effort required for data sharing and negative data publishing worthwhile. It is difficult to assess "reuse" in itself - but this could also be considered in the future as a potential open-science indicator (PSJ40). Lastly, publishers should also keep improving their system and add extra tools simplifying the infrastructure and making it easy to link/share data (PSJ04).

Box 4 : Open Access Publishing and Data Sharing

- Open access publishing is the most implemented of the six methods. The only perceived barriers are 1) the article processing fees, and 2) as a consequence, the market being behold by commercial publishers
- Open access publishing and data sharing are demanded by most funders, but not by all publishers/journals. Research organisations already support these practices by providing money or having a contract with some publishers.
- Improvements are possible by switching to not-for-profit or academically-led publishers and integrating practices into research assessment, recognition & reward.

Recommendations

- ZonMw/NWO and the Ministry of OCW may intensify the discussion on how the Dutch research landscape could transition out of the commercial publisher system, including the creation of a Dutch, academia-led publisher, supported by the government and large Dutch funders.
- Journal editors could stimulate within their journals more data-sharing policies, monitoring, and Open Sciences rewards (eg. Open Science badges).

10. Systematic Reviews and other considerations

Systematic Reviews

Systematic reviews were a topic slightly touched upon by some interviewees, mainly as an answer to the ongoing discussion in the Dutch House of Representatives on the use and need of systematic reviews for animal studies. The question was raised primarily regarding the potential need to make systematic reviews a prerequisite for obtaining ethical approval to perform animal experiments.

The participants found systematic reviews to be a valuable but time-consuming endeavour that requires specific skills (PSD22, PSD100, PSF14, PSIvD72). One participant pointed out that conducting and training in systematic review would make researchers realise what information is lacking in their study, as this had been their own experience with their systematic reviews. This echoes with the ZonMw impact study from 2021 assessing the effect of conducting systematic reviews; in there, researchers stated that they were more careful of their next animal study planning, conducting and reporting, but also that they tried to teach the gained knowledge within their team (Menon et al., 2021).

> *"That's one of the realisations I had during this (systematic review) 'oh we don't put every detail in there', and that's something that you would like to have if you want to do this systematic review. For me, it's already a realisation and I think that's a good thing." – PSD22*

The idea of making a systematic review a prerequisite before performing animal studies was not seen positively in the current research system; it was argued that it would be too time-consuming, costly, and bureaucratic to do this prior to every animal experiment. Implementing requirements would also require a proper model to fund researchers and provide them with experts' help and/or proper training. At present, little financial and in-kind help is available for researchers to conduct their review. One of the funders mentioned a funding scheme dedicated to systematic reviews regarding animal studies (PSF79), similar to the existing funding scheme in the MKMD program from ZonMw. This type of grant scheme is not yet common practice with other funders, but it can promote and allow the conduct of systematic reviews, also because it provides the researchers with the necessary funding. Moreover, expert help exists but is still developing; only a few groups worldwide provide guidance and tools for systematic reviews of animal studies, such as the meta-research team (RadboudUMC) (formerly SYRCLE), the CAMARADES groups, or BRISA. Though valuable, this support will not be sufficient if all animal researchers were required to do systematic reviews. One participant mentioned that some university libraries can help with systematic searching and that this topic is included in several courses (PSDATA88), e.g., laboratory animal science courses (Article 9 of the Animal Experiments Act). An e-module introducing systematic reviews'

methodology is also available on ETPLAS (the European Training Platform for Laboratory Animal Science).

> *'I think it's too difficult to have it mandatory. It's a very delicate expertise already and by itself, and I think you could fill your whole PhD with doing a systematic review. [...] I would not make it a requirement. If I look as a researcher, I would say it takes too much time" – PSD22*

Other alternatives were mentioned, such as promoting reviews in specific contexts, e.g. when trying to get an overview of all existing models or test translatability, or using systematic searching instead of the whole review process to improve the justification of the chosen animal model and the need for animal studies.

> *"I would really be in strong favour of doing it if, for example, you would like to try to generate an overview of existing models for a certain disease, or if you would try to have an idea of the translatability of specific animals or specific animal models for a specific thing. There, I'm really sure it would help, and I'm also sure that it would help the field". – PSD100*

> *"Well, I do see a place for systematic reviews, and I would like to broaden that perspective because I think, in many cases, you ideally should conduct a systematic review. In some cases, you could argue that it should be systematic literature research, not necessarily through systematic reviews, but you should be able to demonstrate - and that's often missing at the moment - how you conducted your preliminary research" – PSIvD37*

All in all, systematic reviews are considered valuable and could be better promoted in certain contexts, but having them as a requirement is not yet feasible. To note, systematic reviews were not a primary topic of this study, but came up during development of the interview guides following the increased interest for systematic reviews. A separate study could be conducted to properly assess when and how such reviews should be applied, and how should they be promoted, or made compulsory. Next to this, teaching the methodology of systematic reviews at academic bachelor or master courses would prepare the next generation of scientists to perform such reviews.

Box 5 : Systematic Review Summary

- Systematic reviews were seen as a valuable but time-consuming endeavour that requires specific skills and sufficient funding.
- Participants were not in favour of having a new requirements for reviews but instead suggested promotion of reviews/systematic searching when valuable (e.g. to get an overview of all models, to test translatability, to justify new research)

Recommendations

- ZonMw is encouraged to maintain its funding program within the MKMD program on the training in writing of systematic reviews; other health funders are advised to consider creating similar grant schemes.
- Animal Experimentation Committees (DECs), the Central Authority for Scientific Procedures on Animals (CCD) and Animal welfare bodies (AWB) are encouraged to discuss how systematic searching can strengthen the ethical foundations of applications.
- Universities could add training on systematic reviews to their available courses, in collaboration with existing experts and increase their pool of experts.

Other non-method-specific factors

During the interviews, other non-method-specific factors were also discussed, offering further context for previous sections and the implementation of the five methods. We provide more information on them below:

Researchers and stakeholders expressed concerns about public perception of their work. Funders emphasized that donors' and society's opinions influence current engagement and future requirements. Animal Welfare Body members highlighted the need for increased awareness about animal studies, including explanations for their continued necessity. Communication with the general public is essential and engaged in many institutes by a transparency agreement on animal research. This includes, for instance, lab tours organised by the AWB or animal facility, which frequently result in visitors being pleasantly surprised by the positive living conditions of the animals. Their reactions represent an indicator of how animal research is globally viewed - expectations of suffering for the animals and poor treatment. This ambient stigmatisation toward researchers' work, coupled to societal pressure, can be perceived as an additional burden on researchers, who often simply wish to do good work, comply with Dutch law and/or have an impact on science and healthcare. Moreover, participants mentioned that the current research system is not stimulating researchers to be transparent. Competition, *"publish or perish",* unstable job positions - the entire culture is stimulating

impact and innovativeness at the expense of transparency. This is why integrating Open Science practices into research assessment, and switching to a system focussing on robustness and transparency could help implementation tremendously. In this new culture, Open Science practices will no longer be optional, but integrated into the workflow and will be appreciated and rewarded as such.

Responsibility for implementing transparency methods was a key topic in all interviews. Who should shoulder this responsibility? Overall, participants reached a consensus that it should be a shared effort, with researchers (and their institutions), funders, and journals playing central roles. Funders and journals were highlighted as particularly crucial, given their ability to enforce and monitor practices. Animal welfare bodies and data steward teams were seen as supportive entities, capable of aiding in promotion and training, but not necessarily driving the initiative forward by themselves. Institutes were urged to provide the necessary support and infrastructure to uphold standards. The government was also mentioned as having a responsibility, albeit more indirectly; as UNL and NFU institutes benefit from public funding, they are inherently supported by the government. Additionally, government-led initiatives like Health-RI or Open Science NL were cited as great promoters of Open Science. While regulations could play a role, it was emphasized that their implementation should involve collaboration and consideration of stakeholders' capabilities. It was mentioned in the interviews that the government felt little legitimacy in placing standards top-down, and might rather provide the means to the proper stakeholders for them to uphold these promises. To facilitate further implementation, it's crucial to assess each stakeholder's strengths and weaknesses in stimulating the implementation of transparency methods. Despite the tendency to point fingers during interviews, stakeholders must wholeheartedly take accountability for what they fund, support, or publish. Failure to do so places an unjust burden solely on researchers, who cannot withhold current expectations for innovativeness, impact, transparency and robustness all by themselves.

11. List of Recommendations

1. **Preregistration:** Dutch funding organisations subsidising animal research should consider making preregistration of animal studies for large preclinical trials mandatory (i.e. trials preceding clinical trials).

2. **Preregistration and ARRIVE guidelines:** Dutch funders are advised to discuss with each other;1) what the type of reward (or sanction) to give for (lack of) compliance with preregistration or ARRIVE, 2) how and when to monitor preregistration in a similar fashion, 3) discuss which existing tools or information to use to monitor ARRIVE and 4) decide if they apply in requirement the “Essential 10” or the whole ARRIVE set. In each case, broad alignment between funders policies are recommended.

3. **Preregistration:** Universities, license holders and animal welfare bodies ought to promote preregistration to university courses (e.g. Article 9, science integrity, the curriculum in general) and the information provided to the researcher (e.g. add information to the instructions/protocols or website).

4. **DMPs & FAIR:** Funders could assess differences and similarities between the information they demand in terms of DMP and FAIR requirements for animal studies to avoid redundancy. Together with UNL & NFU, they could investigate the content of DMP templates used by research organisations to achieve greater alignment between what institutes and what funders ask and highlight needs for discipline-specific demands.

5. **Open Science:** Open science communities should discuss with their board of directors and deans on including the adherence to transparency methods to the evaluation and recognition of researchers.

6. **Data management:** Deans and the board of directors, in cooperation with their integrity centre or digital competence centres, should consider the possibility of adding an “entry protocol” around data management for PhDs and new employees.

7. **ARRIVE guidelines:** Animal welfare bodies may verify that research protocols comply with ARRIVE and see how to ensure aligning of content to allow automated method section generation.

8. **Publishing:** ZonMw/NWO and the Ministry of OCW may intensify the discussion on how the Dutch research landscape could transition out of the commercial publisher

system, including the creation of a Dutch, academia-led publisher, supported by the government and large Dutch funders.

9. **FAIR, ARRIVE & Open Access:** Journal editors could stimulate within their journals more data-sharing policies, monitoring, and Open Sciences rewards (eg. Open Science badges).

10. **Systematic reviews:** ZonMw is encouraged to maintain its funding program within the MKMD program on the training in writing of systematic reviews; other health funders are advised to consider creating similar grant schemes.

11. **Systematic searching:** Animal Experimentation Committees (DECs), the Central Authority for Scientific Procedures on Animals (CCD) and Animal welfare bodies are encouraged to discuss how systematic searching can strengthen the ethical foundations of applications.

12. **Systematic reviews:** Universities could add training on systematic reviews to their available courses, in collaboration with existing experts and increase their pool of experts.

12. Conclusion & Discussion

With this report, we have assessed the factors influencing the implementation of six transparency methods (preregistration, DMP, FAIR data, systematic reviews, ARRIVE guidelines and Open Access publishing). Via surveys (with researchers) and interviews (with researchers and stakeholders), we have highlighted that quite some work is needed for these methods to be truly implemented in the animal research workflow. Methods currently supported and implemented by the system, like DMP, FAIR and Open access, are much more ahead of new methods like preregistration and ARRIVE, as they benefit from structural support. Lack of training, encouragement, support and resources, but also awareness issues, competition and social pressure are all barriers to the implementation. For stakeholders, the inability to efficiently monitor the different methods, due to a lack of resources or tools, is the main barrier; novel initiatives from Elsevier and Wageningen University on monitoring datasets related to publications are hence worth mentioning. Their relationship with other stakeholders (e.g. requirements asked by somebody else), the relevance and benefits of the methods, but also societal pressure, and competition ruled their decisions for new requirements. On the other hand, it might also be of interest to look at the implementation and compliance of these six methods in other research fields (Blanco et al. 2019; Johnson et al. 2023; Perrier et al. 2017; Samaan et al. 2013; Williams et al. 2017; Zarghani et al. 2023).

Referring back to the theoretical framework that was used in this study, we could assess that implementation process is influenced by various factors within both the researchers' and stakeholders' systems. To improve the uptake of transparency methods, both systems needs to evolve, especially as they interact with each others. Researchers' capability relies on a delicate balance of receiving adequate support, training, and information from their institutions, animal welfare bodies, and/or data stewards, while also requiring fair and achievable requirements. This links to their motivation, which would increase if the transparency methods were rewarded, integrated and facilitated into the research workflow, so as to value and support methods application, and reduce their administrative burden. For stakeholders, the characteristics of their organisation (e.g. size, structure, means) and their knowledge on the methods heavily influenced their capability. Their opportunity and motivation are often stimulated by other stakeholders, frequently driven by collaboration or the shared goal of enhancing research and supporting researchers (at the exception of journal editors that appeared somewhat disconnected to this process). If the stakeholders' system evolves toward embracing the transparency methods, the researchers' system will follow and together should allow a more sustainable implementation. Moreover, given the importance of the international context of biomedical research, it will also be very valuable if these transparency methods are also internationally implemented. Discussions on these topics could for instance be held within the European Universities Initiative or the EViR Funders Forum .

Even though these transparency methods will increase the transparency and quality of the conducted animal research, it will inevitably lead to an increase in the administrative burden. Rewarding scientists that voluntarily apply these methods may hence be more effective for durable implementation than sanctioning those that do not. As such, to efficiently implement the methods further, a target point is to integrate transparency methods into the assessment, recognition and reward, by both funders, journals and institutes. Secondly, promoting the awareness of these methods is also essential, preferably from the earliest stage possible (e.g. Bachelor, Master's degree). And above all, accountability must be taken up by the different stakeholders to provide the necessary support and incentives, but also to monitor their standard. Investigation of tools to do so will be necessary, but without this combination of demand - support - monitor, the implementation will not be sustainable. As such, non-sustainable implementation of the investigated transparency methods will have consequences for the replication crisis and specifically, the use of laboratory animals.

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14. References

- Arza, V. and M. Fressoli, Systematizing benefits of Open Science practices. Information Services & Use, 2018. 37: p. 463-474.
- Blanco D. et al. Scoping review on interventions to improve adherence to reporting guidelines in health research. BMJ Open, 2019, 9(5), pp.e026589.
- Brainard, J. Open access takes flight. Science, 2021. 371,16-20. DOI:10.1126/science.371.6524.16
- Damschroder, L.J., et al., Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. Implementation Science, 2009. 4(1): p. 50 DOI: 10.1186/1748-5908-4-50.
- Eysenbach G. Citation Advantage of Open Access Articles. PLoS Biol, 2006. 4(5): e157. DOI: 10.1371/journal.pbio.0040157
- Freedman, L.P., I.M. Cockburn, and T.S. Simcoe, The Economics of Reproducibility in Preclinical Research. PLoS Biol, 2015. 13(6): p. e1002165 DOI: 10.1371/journal.pbio.1002165
- Frommlet F. Improving reproducibility in animal research. Sci Rep, 2020;10(1):19239. doi: 10.1038/s41598-020-76398-3.
- Hair K, et al., IICARus Collaboration. A randomised controlled trial of an Intervention to Improve Compliance with the ARRIVE guidelines (IICARus). Res Integr Peer Rev. 2019 Jun 12;4:12. doi: 10.1186/s41073-019-0069-3.
- Janssens M, Gaillard S, de Haan JJ, de Leeuw W, Brooke M, Burke M, Flores J, Kruijen I, Menon JM.L, Smith A, Tiebosch IA.C.W, Weijdema F (2023) How Open Science can support the 3Rs and improve animal research. Research Ideas and Outcomes 9: e105198. DOI: 10.3897/rio.9.e105198
- Jarvis, M.F. and M. Williams, Irreproducibility in Preclinical Biomedical Research: Perceptions, Uncertainties, and Knowledge Gaps. Trends in Pharmacological Sciences, 2016. 37(4): p. 290-302 DOI: 10.1016/j.tips.2015.12.001.
- Jetten M, Grootveld M, Mordant A, Jansen M, Bloemers M, Miedema M, & Celia W.G. van Gelder. Professionalising data stewardship in the Netherlands. Competences, training and education. Dutch roadmap towards national implementation of FAIR data stewardship. Zenodo, 2021. DOI: 10.5281/zenodo.4320504
- Johnson A.L. et al. Clinical trial data-sharing policies among journals, funding agencies, foundations, and other professional organizations: a scoping review. Journal of Clinical Epidemiology, 2023. 154, pp.42-55.
- Leung V, et al.,. ARRIVE has not ARRIVEd: Support for the ARRIVE (Animal Research: Reporting of in vivo Experiments) guidelines does not improve the reporting quality of papers in animal welfare, analgesia or anesthesia. PLoS One. 2018 May 24;13(5):e0197882. doi: 10.1371/journal.pone.0197882.

- Menon J.M.L., Ritskes-Hoitinga M, Pound P, van Oort E. The impact of conducting preclinical systematic reviews on researchers and their research: A mixed method case study. PLoS One. (2021) doi: 10.1371/journal.pone.0260619.
- Menon, J.M.L., on behalf of the Preclinicaltrials.eu Steering Committee, Preclinicaltrials.eu: prospective registration of animal studies, European Heart Journal, Volume 44, Issue 44, 21 November 2023, Pages 4617–4619, DOI: 10.1093/eurheartj/ehad623
- Michie, S., M.M. van Stralen, and R. West, The behaviour change wheel: a new method for characterising and designing behaviour change interventions. Implement Sci, 2011. **6**: p. 42.
- Nilsen, P., Making sense of implementation theories, models and frameworks. Implementation Science, 2015. 10(1): p. 53-53 DOI: 10.1186/s13012-015-0242-0.
- Perrier L. et al. Research data management in academic institutions: A scoping review. PLoS ONE, 2017. 12(5) (no pagination), pp.e0178261.
- Peters, D.H., et al., Implementation research: what it is and how to do it. BMJ, 2013. 347: p.f6753 DOI: 10.1136/bmj.f6753.
- Pound, P. and M. Ritskes-Hoitinga, Is it possible to overcome issues of external validity in preclinical animal research? Why most animal models are bound to fail. J Transl Med, 2018. 16(1): p. 304 DOI: 10.1186/s12967-018-1678-1.
- Rabin, B.A., et al., A glossary for dissemination and implementation research in health. J Public Health Manag Pract, 2008. 14(2): p. 117-23 DOI: 10.1097/01.PHH.0000311888.06252.bb.
- Samaan Z. et al. A systematic scoping review of adherence to reporting guidelines in health care literature. J Multidiscip Healthc, 2013, 6:169-88. doi: 10.2147/JMDH.S43952.
- Van der Naald M, et al. A 3-year evaluation of preclinicaltrials.eu reveals room for improvement in preregistration of animal studies. PLoS Biol. 2021. 19(9):e3001397. doi: 10.1371/journal.pbio.3001397.
- Van der Naald M., et al. Preregistration of animal research protocols: development and 3-year overview of preclinicaltrials.eu. BMJ Open Sci. (2022) 6(1):e100259. doi: 10.1136/bmjos-2021-100259.
- Wilkinson, M., Dumontier, M., Aalbersberg, I. *et al.* The FAIR Guiding Principles for scientific data management and stewardship. *Sci Data* 3, 160018 (2016). https://doi.org/10.1038/sdata.2016.18.
- Williams M., Bagwell J. and Nahm Zozus, M. Data management plans: the missing perspective. Journal of Biomedical Informatics, 2017, 71, pp.130-142.
- Zarghani, M. et al. The Application of Open Science Potentials in Research Processes: A Comprehensive Literature Review. Libri, 2023. vol. 73, no. 2, pp. 167-186. https://doi.org/10.1515/libri-2022-0007.

15. Appendices

Appendix S1: Questionnaires for each transparency methods

1st questionnaire: preregistration of animal studies

Dear ZonMw grantees,

You are invited to participate in our questionnaire, which aims to gather information for the ZonMw pilot study. It should take about 10 minutes to complete.

The main goal of the study is to gather feedback on your experience as researchers regarding several methods used in an effort to improve transparency and quality. ZonMw will use this information to improve and tailor its requests to make them more easily accessible and achievable and to make sure that its policies are of added value. **Your input is therefore essential for tailoring ZonMw's policies.**

The current questionnaire focuses on **the preregistration of your study protocol at Preclinicaltrials.eu**. Therefore, you will be asked several questions about your opinions and experience regarding preregistration.

We would highly appreciate a response to all questions. However, if this is not possible, you may continue to the next question. **Please note**: you can return to a former question at any time, however, you cannot pause the survey and continue later. You can see your progress at the top of the page (with the progress bar).

Your participation in this study is completely voluntary. If you feel uncomfortable answering any questions, you can withdraw from the survey at any point. Additionally, all your information will be kept anonymous and confidential, as this research follows and complies with the data protection act of 2018 and is made primarily for internal use within ZonMw. **By completing this survey, you consent that your answers can be used internally or for future publications**

We kindly thank you for your participation and your time!
Please start with the questionnaire now by clicking on the "Start" button below.

Introductory questions

Throughout the survey, you may scroll down or click the "next question" button to go to the next questions

Q1) Which grant did you receive? (*)

Off road	□
Open Competition	□
Veni	□
Vidi	□
Vici	□
Antibiotica Resistentie (ABR)	□
Dementie Fellowship	□
Another ZonMw grant	□
Hartstichting grant	□

Q1B) What is your current profession?

Undergraduate student □
Research assistant □
PhD student □
Post-doc researcher □
Assistant professor □
Associate professor □
Other academic staff □

Q1C) Please tell us the name of your institute/organisation

Your experience with preregistration

Preregistration of your study protocol is a method enabling transparency of your study design. Additionally, preregistration enables to avoid duplication of unnecessary studies, reduce bias and increase data sharing. The following questions address your opinion and experience with preregistering your study protocol.

Q2) Have you heard about the concept of preregistration before this grant? (*)

Yes □ No □ I don't know □

Q3) Have you ever pre-registered an animal study before this grant? (multiple answers can be picked) (*)

Yes, via Preclinicaltrials.eu □
Yes, in another preclinical protocol registry (e.g. the Animal Study Registry) □
Yes, by making it available online in a general registry (e.g., via the Open Science Framework) □
Yes, by making it available online via your institute (e.g., institute's repository, institute's website) □
Yes, by publishing a registered report □
No □

Q4) Have you heard about Preclinicaltrials.eu before this grant? (*)

Yes □ No □ I don't know □

----------SKIP LOGIC: the ones who answered 'yes' go to Q5), the others go to Q6)----------

Q5) How did you hear about Preclinicaltrials.eu? (multiples answers can be picked)

Conference □
Consortia □
Funding Agency (e.g., ZonMw, NWO, other) □
Scientific papers □
Course (e.g. article 9) □
Superior/Supervisor □
Colleagues □
Friends □
Social Media □

Internet browsing □

Other □

If you choose “Other”, by which means did you hear about Preclinicaltrials.eu?

Q6) Please choose the answer that best fits the following statements about preregistration on Preclinicaltrials.eu: (*)

	Completely Disagree	*Mostly Disagree*	*Slightly Disagree*	*Neither disagree nor agree*	*Slightly Agree*	*Mostly Agree*	*Completely Agree*
Preregistration will improve the quality of my research	□	□	□	□	□	□	□
Preregistration will increase the transparency of my research	□	□	□	□	□	□	□
Preregistration decreases unnecessary animal use	□	□	□	□	□	□	□
The preregistration process on Preclinicaltrials.eu is difficult	□	□	□	□	□	□	□
Preregistration is unnecessary	□	□	□	□	□	□	□
Preregistration is an administrative burden	□	□	□	□	□	□	□
I feel comfortable to preregister on my own	□	□	□	□	□	□	□
In the future, I will pre-register my studies again	□	□	□	□	□	□	□
I would recommend my colleagues/peers to pre-register their study	□	□	□	□	□	□	□
Preregistration should become common practice	□	□	□	□	□	□	□

If applicable, could you please briefly explain your answers for statements you agreed to ("mostly agree"/"completely agree") or disagreed to ("mostly disagree"/"completely disagree")?

Q7) Is your institute stimulating preregistration?(*)

Yes □ No □ I don't know □

----------SKIP LOGIC: if Yes go to question Q8, if No or I don't know go directly to Q9----------

Q8) What actions is your institute taking to implement preregistration? (e.g. providing training, guidance, information documents, or assigned support personnel).

Q9) What type of (further) support would you like to receive from your institute regarding preregistration? (if any)

Q10) Before pre-registering, did you receive/have sufficient information about why preregistration is important? (*)

Yes □ No □ I don't know □

----------SKIP LOGIC: if Yes go to question Q11, if No or I don't know go directly to Q12----------

Q11) How did you acquire this information? (multiple answers can be picked)

Information provided by your institute □
Information provided by ZonMw □
By attending a talk/workshop/seminar on preregistration □
By reading about preregistration □
By discussing it with colleagues/peers □
By browsing the website Preclinicaltrials.eu □
Other □

If you choose "Other", please let us know how you acquired information about the importance of preregistration

Q12) Before pre-registering, did you receive sufficient information on how to pre-register your study design? (*)

Yes □
No, not enough information □
No, no information at all □
I don't know □

----------SKIP LOGIC: if Yes go to question Q13, if No or I don't know go directly to Q14----------

Q13) How did you acquire this information? (multiple answers can be picked)

Information provided by your institute	□
By attending a talk/workshop/seminar on preregistration	□
By reading about preregistration	□
By discussing it with colleagues/peers	□
By browsing the website Preclinicaltrials.eu	□
Other	□

If you choose "Other", please let us know how you acquired information about how to preregister:

Q14) Which factors would **encourage** you to pre-register your study protocol in the future? (e.g. guidance, reward) (*)

Q15) Which factors would **discourage** you to pre-register your study protocol in the future? (e.g. lack of time, concerns about privacy or idea theft) (*)

Q17) What else could ZonMw or other funders do to facilitate preregistration? (e.g., provide key publication/website about preregistration)

Q18) For further analyses of this topic, we would like to perform interviews (± 1 hour) with some of the participants of this questionnaire.
Would you in principle be willing to participate in a semi-structured interview concerning this topic? If yes, you will be sent all of the required information in the near future. (*)
Yes □ No □

Q18) Please give us your e-mail so we can contact you regarding the interview (*)

----------End Questionnaire----------

Thank you for participating in our questionnaire, your input is very valuable to our study! If you would like to make any additional remarks or ask any question, please do not hesitate to contact us by e-mail at: Menon@zonmw.nl

2nd questionnaire: transparency methods at study design (DMP, PREPARE, Systematic Review)

Dear ZonMw grantees,

You are invited to participate in our questionnaire, which aims to gather information for the ZonMw pilot study. It should take about 15 minutes to complete.

The main goal of the study is to gather feedback on your experience as researchers regarding several methods used in an effort to improve transparency and quality. ZonMw will use this information to improve and tailor its requests to make them more easily accessible and achievable and to make sure that its policies are of added value. **Your input is therefore essential for tailoring ZonMw's policies.**

The current questionnaire focuses on methods used for early data management, e.g., creation of a data management plan; and during study design, e.g., use of a systematic review, the PREPARE guidelines, consulting a statistician. Therefore, you will be asked several questions about your opinions and experience regarding these methods.

Do not worry if you are not too familiar with these topics! Your input will provide highly valuable feedback.

We would highly appreciate a response to all questions. However, if this is not possible, you may continue to the next question. **Please note**: you can return to a former question at any time, however, you cannot pause the survey and continue later. You can see your progress at the top of the page (with the progress bar).

Your participation in this study is completely voluntary. If you feel uncomfortable answering any questions, you can withdraw from the survey at any point. Additionally, all your information will be kept anonymous and confidential, as this research follows and complies with the data protection act of 2018 and is made primarily for internal use within ZonMw. **By completing this survey, you consent that your answers can be used internally or for future publications**

We kindly thank you for your participation and your time!
Please start with the questionnaire now by clicking on the "Start" button below.

Introductory questions

Throughout the survey, you may scroll down or click the "next question" button to go to the next questions

Throughout the survey, you may scroll down or click the "next question" button to go to the next questions

Q1) Which grant did you receive? (*)

Off road □
Open Competition □
Veni □
Vidi □
Vici □
Antibiotica Resistentie (ABR) □
Dementie Fellowship □
Another ZonMw grant □
Hartstichting grant □

Q1B) What is your current profession?

Undergraduate student □
Research assistant □
PhD student □
Post-doc researcher □
Assistant professor □
Associate professor □
Other academic staff □

Q1C) Please tell us the name of your institute/organisation

Sharing and reuse of research data

This section gathers questions about your habits regarding sharing and reusing your or other researchers' data

Q2) Have you ever shared your "raw" data for an ongoing and/or published project? (multiple answers can be picked)

Yes, using a USB Flash drive □
Yes, using email □
Yes, as a stand-alone data publication in a data journal □
Yes, in a data repository of my organization □
Yes, in an external data repository (e.g.Figshare) □
Yes, as an appendix or (online) supplementary information to a scientific publication □
Yes, using a shared network drive □
Yes, in another way □
No □
I don't know □

Q2) If "Yes in another way": Could you please specify?

----------Skip logic, if yes, go to Q3, if no or idk, go to Q4----------

Q3)With whom did you share your data? (e.g. colleagues, peers, funders)

Q4) Have you ever reused data from other researchers? (multiple answers can be picked)

Yes, from colleagues □
Yes, from people in my institute □
Yes, from peers in my field □
Yes, from peers in other fields □
No □
I don't know □

Early data management for FAIR data

A data management plan can be used to explain how data collection will be made FAIR (Findable, Accessible, Interoperable, Reusable). The following questions will address the process of making your plan and your opinion regarding FAIR data.

Q5) Before this grant, have you ever heard of making your data FAIR ? (*)

Yes ☐ No ☐ I don't know ☐

Q6) Before this grant, have you ever designed a data management plan to make your data FAIR ? (*)

Yes, multiple times ☐

Yes, once ☐

No ☐

I don't know ☐

Q7) Please choose the answers that best fits the following statement: (*)

I think that….	*Completely Disagree*	*Mostly Disagree*	*Slightly Disagree*	*Neither disagree nor agree*	*Slightly Agree*	*Mostly Agree*	*Completely Agree*
A data management plan is useless for my project	☐	☐	☐	☐	☐	☐	☐
My data management plan will lead to FAIR results	☐	☐	☐	☐	☐	☐	☐
Creating a data management plan is a complex process	☐	☐	☐	☐	☐	☐	☐
A data management plan is necessary to make my data FAIR	☐	☐	☐	☐	☐	☐	☐
Creating a data management plan is an unnecessary bureaucratic procedure	☐	☐	☐	☐	☐	☐	☐
Data FAIRness should be common practice	☐	☐	☐	☐	☐	☐	☐
For my future studies, I intend to use a data management plan	☐	☐	☐	☐	☐	☐	☐

If applicable, could you please briefly explain your answers for statements you disagreed with(“mostly disagree”/” completely disagree”) or agreed to (“mostly agree”/”completely agree”)?

Q8) What aspects of making research data FAIR do you find difficult? (multiple answers can be picked) (*)

Metadata and/or metadata standards ☐

Getting a unique persistent identifier (e.g. DOI, record number) ☐

Finding the proper registry/database/repository to make my data accessible ☐

Data formats and/or standards for reuse ☐

Making my data machine readable ☐

Standardized ontologies/keywords/controlled vocabularies ☐

Provide copyright and license information ☐

Inconsistency in reporting within my field ☐

Other ☐

None ☐

I don’t know ☐

Q9) If applicable, please tell us briefly about any complications or difficulties you faced when designing your data management plan:

Q10) The following questions will focus on the support provided by your institute to design your **data management plan.**
Please choose the answer that best fits the following statement: (*) (multiple answer can be picked)
My institute provides….

A data stewardship department/team for the whole institute ☐

A data steward person assigned in each department ☐

Training on FAIR data ☐

Training on writing Data Management Plans ☐

Information documents on FAIR data (e.g., PDF, flyers) ☐

Information documents on Data Management Plans ☐

A web page explaining the concept of FAIR data ☐

A web page explaining how to write and/or upload my Data Management Plan ☐

None of the above ☐

Q11) If applicable, please tell us your opinion on the informativeness/usefulness of the support provided by your institute to design your data management plan

Q12) If applicable, what additional support would you like to receive to design future data management plan?

Q13) In your grant application, you had to fill either ZonMw's Data Management Plan template online, or the one of your own institute (in the case that is formally approved by ZonMw).
If you used ZonMw's template, is there anything that ZonMw could do to improve the comprehensiveness of their template?

Q14) Which factors would **encourage** you to create data management plans in the future? (e.g., personal guidance, training) (*)

Q15) Which factors would **discourage** you to create data management plans in the future? (e.g., the complexity of the process, lack of resources) (*)

Preparing your study design

A preclinical study must rely on a robust study design to produce reliable results. To enable design quality and transparency, several methods can be used, among which, 1) the use of preclinical systematic reviews, 2) the PREPARE guidelines, and 3) consulting a statistician.
In this section, you will be asked questions about your opinion and experience (if any) regarding these three methods.

Systematic reviews

Systematic reviews of animal studies can be helpful to get a complete and critical overview of all already available evidence. Additionally, it showed to help researchers with their future study design.

Q16) Is your current research project based on a (systematic) review ? (multiple answers can be picked) (*)

Yes, reviews were used for the literature background ☐

Yes, reviews were used to design this study ☐

Yes, I performed a systematic review before this project ☐

No ☐

I don't know ☐

Q17) What factors would **encourage** you to conduct a systematic review of preclinical studies? (multiple answers can be picked) (*)

Training ☐

Coaching/guidance during the review process ☐

Funding ☐

Enough time available ☐

An interesting topic/interest ☐

If results can be used to guide future experiment(s) ☐

If the review would bring value to my field ☐

If the review generates publishable content ☐

Support from your superior/boss ☐

Possibility to use a contractor to perform the review for me ☐

Possibility to share the workload with colleagues/peers/another team ☐

Possibility to perform the review process faster, e.g. by using AI, text mining ☐

Other ☐

Q17) If you choose "other", please tell us briefly what other factors would encourage you to conduct a systematic review of preclinical studies

PREPARE guidelines

The PREPARE guidelines aims to improve preclinical studies by providing a list of important aspect to consider during study design (e.g., validity of the design, bias, statistical analysis). Its objective is not to be used mandatorily but to guide researchers when creating their study design.

Q19) Have your heard about the PREPARE guidelines before? (*) (https://norecopa.no/prepare)

Yes ☐ No ☐ I don't know ☐

----------SKIP LOGIC: the ones who answered 'yes' go to Q20), the others go to Q22)----------

Q20) Have you ever used the PREPARE guidelines ? (*)

Yes, to design previous project(s) ☐

Yes, to design my current project ☐

Yes, to design previous and current projects ☐

No ☐

I don't know ☐

----------SKIP LOGIC: the ones who answered 'yes' go to Q21), the others go to Q22)----------

Q21) Please choose the answer that best fits the following statements: (*)

	Completely Disagree	*Mostly Disagree*	*Slightly Disagree*	*Neither disagree nor agree*	*Slightly Agree*	*Mostly Agree*	*Completely Agree*
the PREPARE guidelines difficult to apply	☐	☐	☐	☐	☐	☐	☐
the PREPARE guidelines are unpractical	☐	☐	☐	☐	☐	☐	☐
The PREPARE guidelines are unnecessary bureaucracy	☐	☐	☐	☐	☐	☐	☐
The PREPARE guidelines are efficient to improve study design	☐	☐	☐	☐	☐	☐	☐
In the future, I will use the PREPARE guidelines again	☐	☐	☐	☐	☐	☐	☐
I would recommend my colleagues/peers to use the PREPARE guidelines	☐	☐	☐	☐	☐	☐	☐

I think the PREPARE guidelines should become common practice	☐	☐	☐	☐	☐	☐	☐

If applicable, could you please briefly explain your answers for statements you disagreed with(“mostly disagree”/” completely disagree”) or agreed to (“mostly agree”/”completely agree”)?

Q22) Can you please tell us why you did not use the PREPARE guidelines? (multiple answers can be picked) (*)

I did not know how to use them properly ☐

I could not find proper information about them ☐

It was not mandatory ☐

I had no time ☐

I thought I did not need them ☐

I did not see added value ☐

I used the ARRIVE guidelines to help me with my design ☐

They are not widely known yet ☐

No opinion ☐

Consulting a statistician

A statistician can be involved in preclinical studies to advice researchers e.g. on study design, power calculation, experimental units, statistical design, and statistical analyses.

Q23) Have you ever consulted a statistician to help you with a study? (*)

Yes ☐ No ☐ I don’t know ☐

----------SKIP LOGIC: the ones who answered ‘yes’ go to Q21), the others go to Q22)----------

Q24) For which stage(s) of your study did you request help from a statistician?

To design the study ☐

To perform the study ☐

To analyse the result ☐

To write the result ☐

Other ☐

Q25) Can you please tell us why you did not consult a statistician for your study? (multiple answers can be picked) (*)

I did not know who to contact in my institute ☐

My grant could not cover the help of a statistician ☐

It was not mandatory ☐

My team had sufficient statistical knowledge ☐

I had no time ☐

The statistician(s) were too busy to help us when requested ☐

I did not see added value ☐

No opinion ☐

Q26) For further analyses of this topic, we would like to perform interviews (± 1 hour) with some of the participants of this questionnaire.
Would you in principle be willing to participate in a semi-structured interview concerning this topic? If yes, you will be sent all of the required information in the near future. (*)

Yes ☐ No ☐

Q27) Please give us your e-mail so we can contact you regarding the interview.

Q28) Do you have any other comments/remarks:

----------End Questionnaire----------

Thank you for participating in our questionnaire, your input is very valuable to our study! If you would like make any additional remarks or ask any question, please do not hesitate to contact us by e-mail at: Menon@zonmw.nl

3rd questionnaire: FAIR data

Dear ZonMw grantees,

You are invited to participate in our questionnaire, which aims to gather information for the ZonMw pilot study. It should take about 10 minutes to complete.

The main goal of the study is to gather feedback on your experience as researchers regarding several methods used in an effort to improve transparency and quality. ZonMw will use this information to improve and tailor its requests to make them more easily accessible and achievable and to make sure that its policies are of added value. **Your input is therefore essential for tailoring ZonMw's policies.**

The current questionnaire focuses on **making your data FAIR.** Therefore, you will be asked several questions about your opinions and experience with FAIR data.

Your participation in this study is completely voluntary. If you feel uncomfortable answering any questions, you can withdraw from the survey at any point. Additionally, all your information will be kept anonymous and confidential, as this research follows and complies with the data protection act of 2018 and is made primarily for internal use within ZonMw. **By completing this survey, you consent that your answers can be used internally or for future publications**

We would highly appreciate a response to all questions. However, if this is not possible, you may continue to the next question. **Please note**: you can return to a former question at any time, however, you cannot pause the survey and continue later. You can see your progress at the top of the page (with the progress bar).

We kindly thank you for your participation and your time!
Please start with the questionnaire now by clicking on the "Start" button below.

Introductory questions

Throughout the survey, you may scroll down or click the "next question" button to go to the next questions

Q1) Which grant did you receive? (*)

Off road	□
Open Competition	□
Veni	□
Vidi	□
Vici	□
Antibiotica Resistentie (ABR)	□
Dementie Fellowship	□
Another ZonMw grant	□
Hartstichting grant	□

Q1B) What is your current profession?

Undergraduate student	□
Research assistant	□
PhD student	□
Post-doc researcher	□

Assistant professor □
Associate professor □
Other academic staff □

Q1C) Please tell us the name of your institute/organisation

Awareness and current habits

FAIR data are data meeting the principles of being Findable, Accessible, Interoperable, and Reusable (https://www.go-fair.org/fair-principles/).

Q2) Have you ever heard of "FAIR data" before? (*)

Yes ☐ No ☐ I don't know ☐

Q3) In your current ways of working, you may already make your research data FAIR, open, and/or transparent.

Please score the statements below on a scale of 1-5 by stating 1) which task(s) you think is of importance to make research data , column 'Importance' (1: not important, 5: very important), and 2) indicate which of these tasks have already been incorporated in your way of conducting research, column 'Habit' (1: never performed, 5: always performed). If you don't know how to answer or if one line does not apply to you/your field, please put a cross in the column "N/A or I don't know". (*)

	Importance					Habit					
	Not important Very important					Never Always					N/A or I don't know
	1	2	3	4	5	1	2	3	4	5	
I keep notes of how I collected/generated my data (including software used)											
I keep notes of how I edited/converted my data											
I keep notes of all my progress and/or experimental methods with corresponding results in an (online) lab journal											
I run quality checks on my data to ensure it is consistent, correct and complete											
I save my files in common format (e.g. pdf, csv, rtf, tif)											
I make sure to use standardised terms and ontologies											

I store back-ups of my files (e.g. online, on a server, cloud, hard drive, or USB stick)											
I upload **my raw data** online where it is findable for people outside my institute (e.g. repository, catalogue, institute storage)											
I upload **my processed data** in a repository where it is findable for people outside my institute (e.g. repository, catalogue, institute storage)											
I provide persistent identifiers to my uploaded files											
I provide 'read me' files and/or metadata when I share my data with others, making it possible to reproduce my research											

Information provided by funders

Q9) Do you know what your funder FAIR data/data management policy is and where you can find this policy document and guidance? (*)

Yes, I know what it is and where to find it ☐

Yes, I know what it is but not where to find it ☐

No ☐

I don't know ☐

Q10A) Have you ever visited your funder's FAIR data/data management website page?

Yes ☐ No ☐ I don't know ☐

----------SKIP LOGIC: the ones who answered 'yes' go to Q11), the others go to Q12)----------

Q11) For what purpose(s) have you visited the FAIR data and/or data management website page?

Q12A) Is the information provided by your funder regarding FAIR data and data management clear? Think of the conditions taken up in the call text, grant letter, FAIR data/data management website (including the policy document).

Clear and complete ☐

Clear but not complete ☐

Complete but not clear ☐

Neither clear or complete ☐

I don't know ☐

Q12B) In your opinion, what information/guidance could be added to improve clearness and/or completeness ?

Your experience with making research data FAIR

Q13) The following questions address your experience with making your research data FAIR. Please choose the answer that best fits the following statement: (*)

	Completely Disagree	*Mostly Disagree*	*Slightly Disagree*	*Neither disagree nor agree*	*Slightly Agree*	*Mostly Agree*	*Completely Agree*
I am able to make my research data FAIR by myself	☐	☐	☐	☐	☐	☐	☐
I am able to make my research data FAIR with help	☐	☐	☐	☐	☐	☐	☐
I know who to contact within my institution to help me make my research data FAIR	☐	☐	☐	☐	☐	☐	☐
I received sufficient guidance to make my research data FAIR	☐	☐	☐	☐	☐	☐	☐
I have sufficient time to make my data FAIR	☐	☐	☐	☐	☐	☐	☐
I have the appropriate tools/resources	☐	☐	☐	☐	☐	☐	☐

to make my research data FAIR							
I routinely make my research data FAIR	☐	☐	☐	☐	☐	☐	☐

Q14) If applicable, could you please briefly explain your answers for the statements you agreed to ("mostly agree"/"completely agree") or disagreed to ("mostly disagree"/" completely disagree")?

Your opinion about FAIR data

Q15) The following questions address your opinion about FAIR data. Please choose the answer that best fits the following statement: (*)

Making my research data FAIR….	*Completely Disagree*	*Mostly Disagree*	*Slightly Disagree*	*Neither disagree nor agree*	*Slightly Agree*	*Mostly Agree*	*Completely Agree*
Demands a lot of effort	☐	☐	☐	☐	☐	☐	☐
Adds unnecessary bureaucracy	☐	☐	☐	☐	☐	☐	☐
Can influence how other researchers perceive my work	☐	☐	☐	☐	☐	☐	☐
Can improve the quality of my research project	☐	☐	☐	☐	☐	☐	☐
Can improve the transparency of my research data	☐	☐	☐	☐	☐	☐	☐
Can improve the impact of my research project	☐	☐	☐	☐	☐	☐	☐
Contributes to scientific and societal reliability of science	☐	☐	☐	☐	☐	☐	☐
Is useful for myself	☐	☐	☐	☐	☐	☐	☐
Is useful for others, e.g., opens opportunities for new research with my data	☐	☐	☐	☐	☐	☐	☐

Q16) If applicable, could you please briefly explain your answers for statements you agreed to ("mostly agree"/"completely agree") or disagreed to ("mostly disagree"/"completely disagree")?

Q17A) Do you think that making your research data FAIR entails risks?

Yes ☐ No ☐ I don't know ☐

Q17B) Please elaborate on your answer

Making research data FAIR – current status at your institute

Q18) The following questions address the process of making research data FAIR in your institute and/or organisation. Please choose the answer that best fits the following statement: (*)

	Completely Disagree	*Mostly Disagree*	*Slightly Disagree*	*Neither disagree nor agree*	*Slightly Agree*	*Mostly Agree*	*Completely Agree*
My institute requests me to make my research data FAIR	☐	☐	☐	☐	☐	☐	☐
My institute encourages me to make my research data FAIR	☐	☐	☐	☐	☐	☐	☐
My institute provides infrastructure to store FAIR data	☐	☐	☐	☐	☐	☐	☐
My institute provides training about FAIR data	☐	☐	☐	☐	☐	☐	☐
My supervisor(s) encourages me to make my research data FAIR	☐	☐	☐	☐	☐	☐	☐
My colleagues make their research data FAIR	☐	☐	☐	☐	☐	☐	☐
My colleagues expect me to make my research data FAIR	☐	☐	☐	☐	☐	☐	☐
My institute provides rewards for teams/individuals complying with FAIR data	☐	☐	☐	☐	☐	☐	☐

Q19) If applicable, could you please elaborate on the support/guideline provided by your institute and/or organisation?

Q20)Would you like to receive (further) training in FAIR data management?

Yes ☐ No ☐ No opinion ☐

----------SKIP LOGIC: the ones who answered 'yes' go to Q21), the others go to Q22)----------

Q21A) What type of training in data management would be useful to you?

Creating metadata for your research data ☐

Understanding persistent identifiers (e.g. DOI, record number) ☐

Storing and backing up your research data ☐

Data formats and standards needed for FAIR ☐

Ethics and legal aspects of content creation ☐

Copyright and intellectual property rights about sharing data ☐

Copyright and intellectual property rights about reusing data ☐

The use of general and specific repositories ☐

Making datasets machine readable ☐

Understanding standardised ontologies, keywords and controlled vocabularies ☐

Other ☐

Q21B) If you choose "other", please let us know what type of training you would like:

Q22) What else could ZonMw/your funder do to facilitate the process of making your research data FAIR ? (*)

Q23) Do you think that your funder's requirements regarding FAIR data are reasonable to achieve? Please elaborate below (*)

Q24) For further analyses of this topic, we would like to perform interviews (± 1 hour) with some of the participants of this questionnaire.

Would you in principle be willing to participate in a semi-structured interview concerning this topic? If yes, you will be sent all of the required information in the near future. (*)

Yes ☐ No ☐

Q25) Please give us your e-mail so we can contact you regarding the interview. (*)

Q26) Do you have any other remarks/comments about FAIR data? If yes, you can elaborate below:

----------End Questionnaire----------

Thank you for participating in our questionnaire, your input is very valuable to our study! If you would like to make any additional remarks or ask any question, please do not hesitate to contact us by e-mail at: Menon@zonmw.nl

4th survey: ARRIVE guidelines

Dear ZonMw grantees,

You are invited to participate in our questionnaire, which aims to gather information for the ZonMw pilot study. It should take about 10 minutes to complete.

The main goal of the study is to gather feedback on your experience as researchers regarding several methods used in an effort to improve transparency and quality. ZonMw will use this information to improve and tailor its requests to make them more easily accessible and achievable and to make sure that its policies are of added value. **Your input is therefore essential for tailoring ZonMw's policies.**

The current questionnaire focuses on the **ARRIVE guidelines.** Therefore, you will be asked several questions about your opinions and experience with FAIR data.

We would highly appreciate a response to all questions. However, if this is not possible, you may continue to the next question. **Please note**: you can return to a former question at any time, however, you cannot pause the survey and continue later. You can see your progress at the top of the page (with the progress bar).

Your participation in this study is completely voluntary. If you feel uncomfortable answering any questions, you can withdraw from the survey at any point. Additionally, all your information will be kept anonymous and confidential, as this research follows and complies with the data protection act of 2018 and is made primarily for internal use within ZonMw. **By completing this survey, you consent that your answers can be used internally or for future publications**

We kindly thank you for your participation and your time!
Please start with the questionnaire now by clicking on the "Start" button below.

Introductory questions

Throughout the survey, you may scroll down or click the "next question" button to go to the next questions

Q1) Which grant did you receive? (*)

Off road □
Open Competition □
Veni □
Vidi □
Vici □
Antibiotica Resistentie (ABR) □
Dementie Fellowship □
Another ZonMw grant □
Hartstichting grant □

Q1B) What is your current profession?

Undergraduate student □
Research assistant □
PhD student □
Post-doc researcher □

Assistant professor □
Associate professor □
Other academic staff □

Q1C) Please tell us the name of your institute/organisation

Q2) For this research project, which ARRIVE guideline did you apply? (*)
ARRIVE (Publication of 2010) □
ARRIVE 2.0 (Publication of 2020) □
I do not remember/I am not sure □

Awareness and experience
The following questions address your experience with applying the ARRIVE guidelines before you received this grant and for your currently granted project.
Q3) Have you ever used the ARRIVE guidelines before this grant? (*) (multiple answers can be picked)
Yes, to write my study manuscript □
Yes, to design my study □
Yes, to execute my study □
No □

I don't know □

----------SKIP Logic: if yes go to Q4, if no go to Q5----------

Q4) What was your motivation to apply the ARRIVE guidelines?

Q5) Can you please tell us why you did not use the ARRIVE guidelines before? (multiple answers can be picked) (*)
□ I did not know about them
□ I did not know how to use them properly
□ I could not find proper information about them □ It was not mandatory
□ I had no time
□ I thought I did not need them
□ I saw no added value
□ No opinion

□ Other

If you picked 'other', please tell us briefly your motivation

Q6) Please choose the answer that best fits the following statements: (*)

	Completely Disagree	*Mostly Disagree*	*Slightly Disagree*	*Neither disagree nor agree*	*Slightly Agree*	*Mostly Agree*	*Completely Agree*
Using the ARRIVE guidelines is a difficult process	□	□	□	□	□	□	□
I understand the importance of complying with the ARRIVE guidelines for reporting	□	□	□	□	□	□	□
The ARRIVE guidelines are beneficial for my research project	□	□	□	□	□	□	□
I have enough time to comply with the ARRIVE guidelines	□	□	□	□	□	□	□
I have enough guidance to comply with the ARRIVE guidelines	□	□	□	□	□	□	□
In the future, I will use the ARRIVE guidelines again	□	□	□	□	□	□	□
I would recommend my colleagues/peers to comply to the ARRIVE guidelines	□	□	□	□	□	□	□
The ARRIVE guidelines should become common practice	□	□	□	□	□	□	□

Q7) If applicable, for the questions you answered at the two ends of the scale ("mostly disagree"/" completely disagree" or "mostly agree"/"completely agree") could you please briefly explain your answers?

Institute support and external influence

Q8) The following questions address the support you may have received from your institute as well as external influences to apply the ARRIVE guidelines.

Please choose the answer that best fits the following statement: (*)

	Completely Disagree	*Mostly Disagree*	*Slightly Disagree*	*Neither disagree nor agree*	*Slightly Agree*	*Mostly Agree*	*Completely Agree*
My institute obligates me to use the ARRIVE guidelines	□	□	□	□	□	□	□
My institute encourages me to use the ARRIVE guidelines	□	□	□	□	□	□	□
My institute provides rewards for teams/individuals complying with the ARRIVE guidelines	□	□	□	□	□	□	□
My institute provides training about the ARRIVE guidelines	□	□	□	□	□	□	□
My institute provides informative sources about the ARRIVE guidelines (e.g. documents, explanatory web page)	□	□	□	□	□	□	□
My supervisor(s) encourage me to use the ARRIVE guidelines	□	□	□	□	□	□	□
The Animal Welfare Body encourages me to use the ARRIVE guidelines	□	□	□	□	□	□	□
My animal facility encourages/facilitates the use of the ARRIVE guidelines	□	□	□	□	□	□	□
My colleagues expect me to use the ARRIVE guidelines	□	□	□	□	□	□	□
My colleagues use the ARRIVE guidelines	□	□	□	□	□	□	□
The ARRIVE guidelines are commonly used in my field	□	□	□	□	□	□	□

Q9) If applicable, could you please elaborate on the support/guideline provided by your institute and/or organisation?

Q10) Which factors would **encourage** you to comply to the ARRIVE guidelines in the future? (*)

Q11) Which factors would **discourage** you to comply to the ARRIVE guidelines in the future? (*)

Q12) What could ZonMw/other funders do to facilitate your compliance with the ARRIVE guidelines?

Q13) For further analyses of this topic, we would like to perform interviews (± 1 hour) with some of the participants of this questionnaire.
Would you in principle be willing to participate in a semi-structured interview concerning this topic? If yes, you will be sent all of the required information in the near future. (*)
Yes □ No □

Q14) Please give us your e-mail so we can contact you regarding the interview.

Q15) Do you have any other remarks/comments about the ARRIVE guidelines? If yes, you can elaborate below:

----------End Questionnaire----------

Thank you for participating in our questionnaire, your input is very valuable to our study! If you would like to make any additional remarks or ask any question, please do not hesitate to contact us by e-mail at: Menon@zonmw.nl

5th questionnaire: Open Access Publishing and FAIR

Dear ZonMw grantees,

You are invited to participate in our questionnaire, which aims to gather information for the ZonMw pilot study. It should take about **15 minutes** to complete.
The main goal of the study is to gather feedback on your experience as researchers regarding several methods used in an effort to improve transparency and quality. ZonMw will use this information to improve and tailor its requests to make them more easily accessible and achievable and to make sure that its policies are of added value. **Your input is therefore essential for tailoring ZonMw's policies.**
The current questionnaire focuses on open access publishing. Therefore, you will be asked several questions about your opinions and experience with making your manuscript open access.
We would highly appreciate a response to all questions. However, if this is not possible, you may continue to the next question. **Please note:** you can return to a former question at any time, however, you cannot pause the survey and continue later. You can see your progress at the top of the page (with the progress bar).
Your participation in this study is completely voluntary. If you feel uncomfortable answering any questions, you can withdraw from the survey at any point. Additionally, all your information will be kept anonymous and confidential, as this research follows and complies with the data protection act of 2018 and is made primarily for internal use within ZonMw. **By completing this survey, you consent that your answers can be used internally or for future publications.**
We kindly thank you for your participation and your time!
Please start with the questionnaire now by clicking on the "Start" button below.

Introductory questions

Throughout the survey, you may scroll down or click the "next question" button to go to the next questions

Q1) Which grant did you receive? (*)

Off road □
Open Competition □
Veni □
Vidi □
Vici □
Antibiotica Resistentie (ABR) □
Dementie Fellowship □
Another ZonMw grant □
Hartstichting grant □

Q1B) What is your current profession?

Undergraduate student □
Research assistant □
PhD student □
Post-doc researcher □
Assistant professor □
Associate professor □
Other academic staff □

Q1C) Please tell us the name of your institute/organisation

Making your publication available in open access

Awareness about making publication available in open access

The following questions will address your awareness about making your publication available in open access.

Q2) Before this grant, have you ever heard about making publications available in open access ? (*)

Yes ☐ No ☐ I don't know☐

----------SKIP logic: if yes go to Q3, if no go to Q7----------

Q3) Which routes can you describe to make a publication available in open access?

Q4) Have you ever made your publications available in open access before this grant? (*)

Yes ☐ No ☐ I'm not sure ☐

----------SKIP logic: if yes go to Q5, if no go to Q7----------

Q5) What is your preferred open access route, if any? Please explain

Q6) Before this grant, have you ever made other type of research output besides journal articles available in open access?

Yes, monograph ☐

Yes, books ☐

Yes, conference proceeding ☐

Yes, grey literature ☐

Yes, research data ☐

Yes, model(s) ☐

Yes, artefact(s) ☐

Yes, protocol(s) ☐

Yes, prototype(s) ☐

Yes, digital tool(s)/software(s) ☐

Yes, demonstration(s)/presentation(s) ☐

Yes, code ☐

Yes, other ☐

No ☐

I don't know ☐

Q7A) Before this grant, have you ever published your articles under an open Creative Commons license?

Yes ☐ No☐ I don't know what a creative common license is☐

----------SKIP logic: if yes go to Q7B, if no go to Q8----------

Q7B) Could you please tell us why you chose to publish under an open Creative Commons license?

Q8) In your opinion, what are the most important features of a journal when it comes to choosing one to submit a publication? Please score the following propositions (on a scale of 1-5, 1 being not important at all, 5 being very important).

	Not important Very important				
	1	2	3	4	5
Having a fast peer-review process					
Being a prestigious journal (e.g. most respected journal in your field)					
Publishing all the results of my research project					

Making sure my data are reusable					
Low publication fees					
The visibility and dissemination of my work					
The impact factor of a journal					
Clear submission system					
Transparent and constructive peer review process					
No word restriction					
The possibility to provide appendix/supplementary materials					
Making sure that the results are freely accessible online to everybody					
Quality before quantity and speed					

Information provided by ZonMw/by your funder

Q9) Do you know what your funder Open Access policy is and where you can find this policy document and guidance? (*)

Yes, I know what it is and where to find it ☐

Yes, I know what it is but not where to find it ☐

No ☐

I don't know ☐

Q10) Have you ever visited your funder's Open Access website page? If yes, for what purpose?

Q11) Is the information provided by your funder regarding Open Access publishing clear? Think of the conditions taken up in the call text, grant letter, Open Access website (including the policy document).
If not, what information / guidance is missing in your opinion?

Your opinion and experience with open access publishing

The following questions evaluate your opinion and experience regarding open access publishing.

Q12) Your funder requested you to make all publications generated from your grant (wholly or partly) immediately available in open access. How did you make your publication available ? (*)
Publication in a full gold open access journal

☐

(golden route: authors pay publication fees but in exchange their publication is available to everyone online for free)

Deposit (a version of) the article in a repository

☐

(green route: author upload immediality, without embargo, a copy of their preprint or accepted manuscript in an open access repository)

Publication in a hybrid journal having a transformative agreement with the VSNU and/or UKB ☐

(hybrid route: authors publish their manuscript in a journal having a subscription system but which may publish some articles in open access, sometimes for reduced or no publication fees depending on the agreement)

Other

☐

----------Skip logic: each participant answer a list of questions regarding the method they picked----

-

Q13) Please explain briefly why you chose this/these route(s) to make your publication(s) available (*)

Q14) Did you experience any difficulties when making your publications available in open access? If yes, what difficulties?

Q15) Please choose the answer that best fits with the following statement: (*)

Publishing my publication in an open access/hybrid journals… OR making my publication available open access	*Completely Disagree*	*Mostly Disagree*	*Slightly Disagree*	*Neither disagree nor agree*	*Slightly Agree*	*Mostly Agree*	*Completely Agree*	*No opinion /NA*
Demands a lot of efforts	☐	☐	☐	☐	☐	☐	☐	☐
Costs too much money	☐	☐	☐	☐	☐	☐	☐	☐
(for the gold or hybrid route) Is unnecessary, as I already provide my publication online (e.g. in a repository)	☐	☐	☐	☐	☐	☐	☐	☐
Involves risks	☐	☐	☐	☐	☐	☐	☐	☐
Involves lower quality compared to traditional publishing in subscription journals	☐	☐	☐	☐	☐	☐	☐	☐
Can increase the dissemination of my work	☐	☐	☐	☐	☐	☐	☐	☐
Is useful for myself	☐	☐	☐	☐	☐	☐	☐	☐
Is useful for others	☐	☐	☐	☐	☐	☐	☐	☐
Should become common practice	☐	☐	☐	☐	☐	☐	☐	☐

Q15) If applicable, for the questions you answered at the two ends of the scale (“mostly disagree”/” completely disagree” or “mostly agree”/”completely agree”) could you please briefly explain your answers?

Support by your institute

Q16) The following question address the status and support of your institute regarding making your publications available in open access. Please choose the answer that best fits the following statement: (*)

	Completely Disagree	*Mostly Disagree*	*Slightly Disagree*	*Neither disagree nor agree*	*Slightly Agree*	*Mostly Agree*	*Completely Agree*
My institute request me to publish in an open access journal	☐	☐	☐	☐	☐	☐	☐
My institute encourages me to publish in an open access journal	☐	☐	☐	☐	☐	☐	☐
My institute encourages me to make my publication available in open access (e.g. via a repository, on the institute website)	☐	☐	☐	☐	☐	☐	☐
My institute/ department covers publication fees	☐	☐	☐	☐	☐	☐	☐
My institute focuses primarily on the number of articles I publish, not on the openness of the journals	☐	☐	☐	☐	☐	☐	☐
My institute focuses on the type of journal (impact factor) I publish my articles in, not on the openness of the journals	☐	☐	☐	☐	☐	☐	☐
My institute provides training on open access publishing	☐	☐	☐	☐	☐	☐	☐
My colleagues expect me to make my publications available in open access	☐	☐	☐	☐	☐	☐	☐
My colleagues make their publications available in open access	☐	☐	☐	☐	☐	☐	☐
My institute provides rewards for teams/individuals making their publications available in open access	☐	☐	☐	☐	☐	☐	☐

Q17) If applicable, could you please elaborate on the support provided by your institute to make your publication available in open access?

Q18) Would you like to receive (further) training on open access publishing? (*)

Yes ☐ No ☐ I don't know

----------SKIP logic: if yes go to Q19), if no or I don't know, go to Q21----------

Q20A) What type of training in open access publishing would be of interest to you?

Publishing "openly" and its advantages/disadvantages ☐

Finding relevant open access journals in your field ☐

Understand the different open access route available ☐

Finding an appropriate repository to archive your work ☐

How to get publication fees covered ☐

Other ☐

Q20B) If you choose "other", please let us know what topic would be of interest to you for future training

Q21) Which factors would **encourage** you to comply to open access publishing in the future? (e.g. funding, guidance) (*)

Q22) Which factors would **discourage** you to comply to open access publishing in the future? (e.g. lack of resources, concerns about theft) (*)

Q23) What could ZonMw/your funder do to facilitate your compliance to open access publishing? (*)

FAIR data

Q24) For this project, you were asked to design a data management plan. Did you face any issues to apply this plan in practice or made any amendments?? (*)

Yes ☐ No ☐ I don't know ☐

----------SKIP logic: if yes go to Q25, if no or I don't know, go to Q27----------

Q25) What issues did you face?

Q26) What type of amendment did you perform?

Q27) Which factors would **encourage** you to make your research data FAIR in the future? (e.g. guidance, training) (*)

Q28) Which factors would **discourage** you to make your research data FAIR in the future? (e.g., lack of resources, concerns that your data will be used without referral) (*)

Q29) For further analyses of this topic, we would like to perform interviews (± 1 hour) with some of the participants of this questionnaire.
Would you in principle be willing to participate in a semi-structured interview concerning this topic? If yes, you will be sent all of the required information in the near future. (*)

Yes ☐ No ☐

Q30) Please give us your e-mail so we can contact you regarding the interview.

Q31) Do you have any other remarks/comments about making publications available in open access or FAIR data? If yes, you can elaborate below:

----------End Questionnaire----------

Thank you for participating in our questionnaire, your input is very valuable to our study! If you would like to make any additional remarks or ask any question, please do not hesitate to contact us by e-mail at: Menon@zonmw.nl

Appendix S2: Informed consent form

Informed Consent Form for Participants in the Qualitative Study

"ZonMw Pilot study – implementation of transparency methods "

Principal Investigator
Julia Menon on behalf of ZonMw; Bas de Waard, ZonMw representative
Telephone: +33 6 26 36 84 38
Menon@zonmw.nl
Waard@zonmw.nl

This Informed Consent Form has two parts:
• Information Sheet (to share information about the study with you)
• Certificate of Consent (for signatures if you choose to participate)

You will be given a copy of the full informed consent form

Part I: Information Sheet

You are being asked to take part in a research study. Before you decide to participate in this study, it is important that you understand why the research is being done and what it will involve. Please read the following information carefully and ask the researcher if anything is not clear or if you need more information.

Introduction

I'm Julia Menon, a fellow researcher at ZonMw. I'm currently performing a case study for ZonMw regarding their requirements for transparency methods where I ask researchers about their experience with the requirements.

Purpose of the Study

ZonMw and other funders such as NWO wish to implement best practices in research. In that respect, they advice or request several methods and requirements in their call, grant schemes and policies. In a pilot, ZonMw pushes forward new and older methods regarding transparency and open access in preclinical research. These methods includes preregistration, FAIRification of data, the ARRIVE guidelines, and open access (publishing). Of course, these new methods cannot be implemented in animal studies without the researchers – implementation that can be influenced by researchers, their institute, and the science community. Therefore, we aim to investigate the factors that prevent and facilitate the implementation of these transparency methods in practice, to ultimately tailor ZonMw policies and advice stakeholders on best practice to implement these transparency methods.

Procedure
This research will involve your participation in a one-hour interview, where you will be kindly asked open-questions. During the interview, I (Julia Menon) will interview you via teleconference, using *Zoom,* and will record our exchange for further analysis. If you do not wish to answer any of the questions during the interview, you may say so, and we will move on to the next question. No one else but I will be present unless you would like someone else to be there. We can then invite them to the call.
The information recorded is confidential; it will be transcribed verbatim. Only the ZonMw representative for this project (dr. Bas de Waard) will have access to the recording and the information documented during your interview. Additionally, your information will be primarly used for an internal ZonMw report only. This report will have an accessible/published version. The entire interview will be recorded, but no-one will be identified by name in the data analysis or any other future steps of publication. The recording will be destroyed after 16 weeks.

Participant Selection
You are being invited to take part in this research because we feel that your influence and opinion due to your position would be highly valuable. In particular, to highlight how the transparency methods are being used and/or implemented in your institute

Voluntary Participation
Your participation in this study is voluntary. It is up to you to decide whether or not to take part in this study. If you choose to take part, you will be asked to sign this informed consent form. After you sign the consent form, you are still free to withdraw at any time and without giving a reason. Withdrawing from this study will have no bearing on your job or any work-related evaluations or reports, nor will it affect the relationship you have, if any, with the researchers. If you withdraw from the study before data collection is completed, your data will be returned to you or destroyed.

Risks
The questions asked during the interview will be related to your opinion on transparency and the process occurring at your institute. If you do not feel comfortable with this topic for personal, work-related, or other reasons, you may decline to answer any or all questions, and you may terminate your involvement at any time.

Benefits
There will be no direct benefit to you, but your participation will help us to identify barriers and facilitators to the implementation of transparency methods. This would result in a better understanding of institute's contribution to implementation and ultimately enable to refine ZonMw's policies.

Confidentiality
Confidentiality, privacy and anonymity is the main priority in our study. Every effort will be made by the researcher to preserve your confidentiality by the following:

- Assigning a code name to your collected information, as well as on all research notes and documents

- No mention of your profession, age, or any distinct characteristic that may be associated with your person.
- Interviews will be done and recorded on a trustworthy software.
- Digitally secure your data
- Access will be limited to the ZonMw representative (dr. Bas de Waard), and I (Julia Menon)
- Ensure destruction of the recording within 16 weeks after the original interview.

Participant data will be kept confidential except in cases where the researcher is legally obligated to report specific incidents. These incidents include, but may not be limited to, incidents of abuse and suicide risk.

Contact Information
If you have questions at any time about this study, you may contact the researcher whose contact information is provided on the first page.

Part II: Certificate of Consent
To be filled by the participant
I have read and I understand the provided information and have had the opportunity to ask questions.
I understand that my participation is voluntary and that I am free to withdraw at any time, without giving a reason and without cost.
I have had the opportunity to ask questions and any questions I had have been answered to my satisfaction.
I understand that I will be given a copy of this consent form.
I voluntarily agree to take part in this study.

Name of Participant _____

Signature

Date _____

To be filled by the investigator
I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

Name of Investigator_____

Signature

Date _____

Appendix S3: Number of respondents per questionnaire

For the study design survey (DMP, PREPARE, Systematic Reviews)

Question numbers	Number of answers	Drop-outs
Q1-Q2	23	0
Q3	20	3
Q4-Q13	22	Recover 2
Q14-end	20	2

For the Preregistration survey

Question numbers	Number of answers	Drop-outs
Q1-Q8	16	0
Q9-Q13	15	1
Q14-Q17	14	2
Q18-end	13	3

For the FAIR survey: there was no drop out

For the ARRIVE guidelines survey:

Question numbers	Number of answers	Drop-outs
Q1-Q5	4	0
Q6-end	3	1

For the Open access publishing survey:

Question numbers	Number of answers	Drop-outs
Q1-Q6	20	0
Q7-end	19	1

Appendix S4: PREPARE results

When asked about PREPARE guidelines, only three participants had heard about them, and two used them either for their current or past project. The other participants mentioned that they did not use the PREPARE guidelines, amongst other reasons, because they used ARRIVE guidelines for their design (n=7/28), the guidelines are not widely known and were not mandatory (n=4/28), or they did not see their added value, or thought they did not need them (n=3/28).

For the two who used the PREPARE guidelines, they found them rather easy to apply and practical. They agreed that they were efficient to improve their study design and mentioned that they will use them again in the future. Lastly, they stated that they would recommend them to peers/colleagues and that they should become common practice.

Appendix S5: Researchers' sharing habit

(from the transparency at study design survey and open access publishing survey).

Participants mentioned that they have shared raw data for ongoing and/or published project at the exception of three (n=3/20). In general, raw data was shared with colleagues and peers, and occasionally with journal or funders (n=1/20 respectively). These data were shared in majority via e-mail (n=13/20), via data repositories (internal to their institute, or external) or using a shared network drive (n=10/20), using a USB flash drive (n=9), or as supplementary material in a publication (n=9/20). One participant even published a stand alone data publication in a data focused journal.
Besides journal articles, researchers shared other type of data (raw and processed). They were in majority protocols, books, conference proceedings and research data; but also presentations for instance (Figure S5.1).

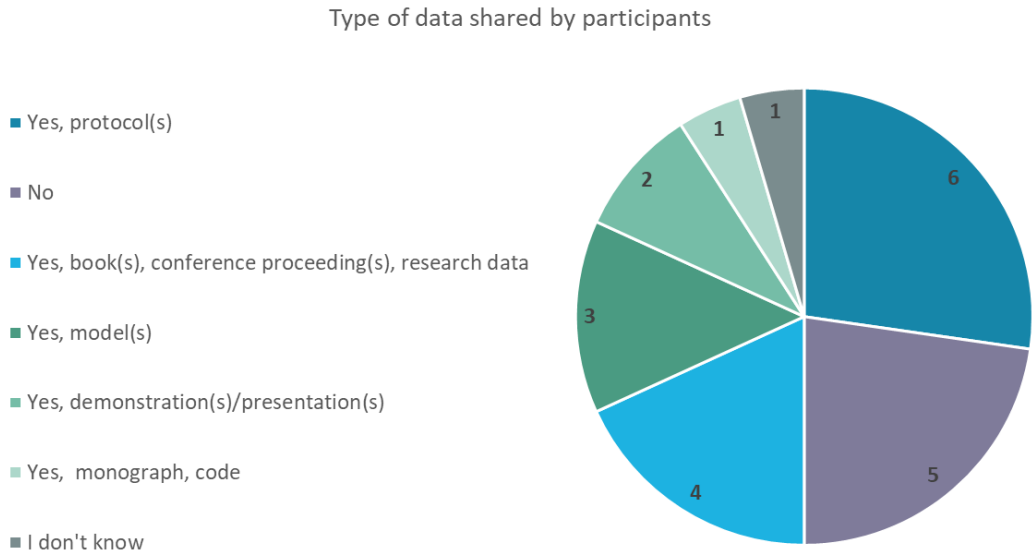

Figure S5.1: type of data shared by the participants
Participants could also choose grey literature, artefacts, prototypes, digital tools, softwares and "other", but none of them chose these options

Colophon

ZonMw is The Dutch Organisation for knowledge and innovation in health, healthcare and well-being

Working with knowledge to boost good health for all: that is what ZonMw is about. We programme and fund research and innovation in health, healthcare and well-being, promote the use of knowledge developed and highlight where knowledge is needed. Our main contractors are the Ministry of Health, Welfare and Sport and the Dutch Research Council (NWO).
For further information, please contact the programme MKMD through email mkmd@zonmw.nl or by telephone (+31 (0)70 349 51 11).

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