novo nordisk
foundation
Benefitting people and society

2021
Annual Impact Report

Societal impact

of the Novo Nordisk Foundation

Contents

“Investing in research and development in society contributes to creating knowledge, employment, growth and innovation of products and services to improve people’s health and the sustainability of society and the planet.”

— **Lars Rebien Sørensen**
Chairman, Board of Directors, Novo Nordisk Foundation

Preface

The Novo Nordisk Foundation is an independent Danish enterprise foundation with philanthropic and corporate purposes. Its vision is to improve people’s health and the sustainability of society and the planet. To fulfil this vision, it pursues two three-pronged missions in relation to its purposes:

The Foundation’s philanthropic mission is to

- progress research and innovation in the prevention and treatment of cardiometabolic and infectious diseases;
- advance knowledge and solutions to support the green transition in society; and
- invest in scientific research, education and innovation to enable a world-class life science ecosystem.

The Foundation’s corporate mission is to

- be an engaged owner of Novo Nordisk A/S, Novozymes A/S and Novo Holdings A/S;
- generate attractive investment returns on the Foundation’s assets; and
- make strategic investments with the main goal of supporting the Foundation’s strategy.

Through its activities, the Foundation aims to make contributions that benefit people and society. The Foundation will support projects in biomedical science, the natural and technical sciences, biotechnology, sustainability, humanities, interdisciplinary research, diabetes hospitals, innovation, education, and social and humanitarian causes. It will remain substantially focused on contributions through fundamental and translational research. In terms of its corporate activities, the Foundation contributes to the economy of society by generating jobs and advancing the development of new technologies and research. In addition, through focused investments in life sciences, it aims to improve the health of people and accelerate the green transition of society through innovative developments in biotechnology and other technologies.

In its philanthropic focus towards 2030, the Foundation will continue to have Denmark as its centre of gravity while at the same time increasing the international reach, considering the interconnected, global nature of the problems it strives to solve, and thereby also strengthening the life sciences and research environments in Denmark. The corporate activities of the Foundation are global in scope.

We adopt a long-term perspective. Research, innovation, education and investments in companies involve trust in people and taking risks. Improving the health of people and the sustainability of society and the planet takes time. We believe that high-quality activities and interdisciplinary approaches create the ideal research environment for fulfilling a great ambition and for global scientific collaboration and new ideas to flourish. Such an environment has the potential to foster the greatest breakthroughs and find new sustainable solutions to societal challenges.

This impact report documents aspects of the overall contribution to society provided by the Foundation’s philanthropic activities, alongside the impact on society of the Foundation’s corporate activities.

We hope you will enjoy reading this year’s impact report.

Mads Krogsgaard Thomsen,
CEO, Novo Nordisk Foundation

Executive summary

The Novo Nordisk Foundation has two objectives:

1. to provide a stable basis for the commercial and research activities of the companies in the Novo Group; and

2. to support scientific, humanitarian and social purposes.

Our strategy formulates the desired contributions to society for the Foundation across its grant-awarding and commercial activities. We have established an impact framework to analyse, measure and communicate our societal achievements.

This report links our grant-giving and commercial activities in 2021 and before to scientific achievements and societal outcomes beyond science.

In accordance with the Foundation's three-pillar strategy (Health, Sustainability and Life Science Ecosystem), the impact of the Foundation is structured according to nine principles for societal impact.

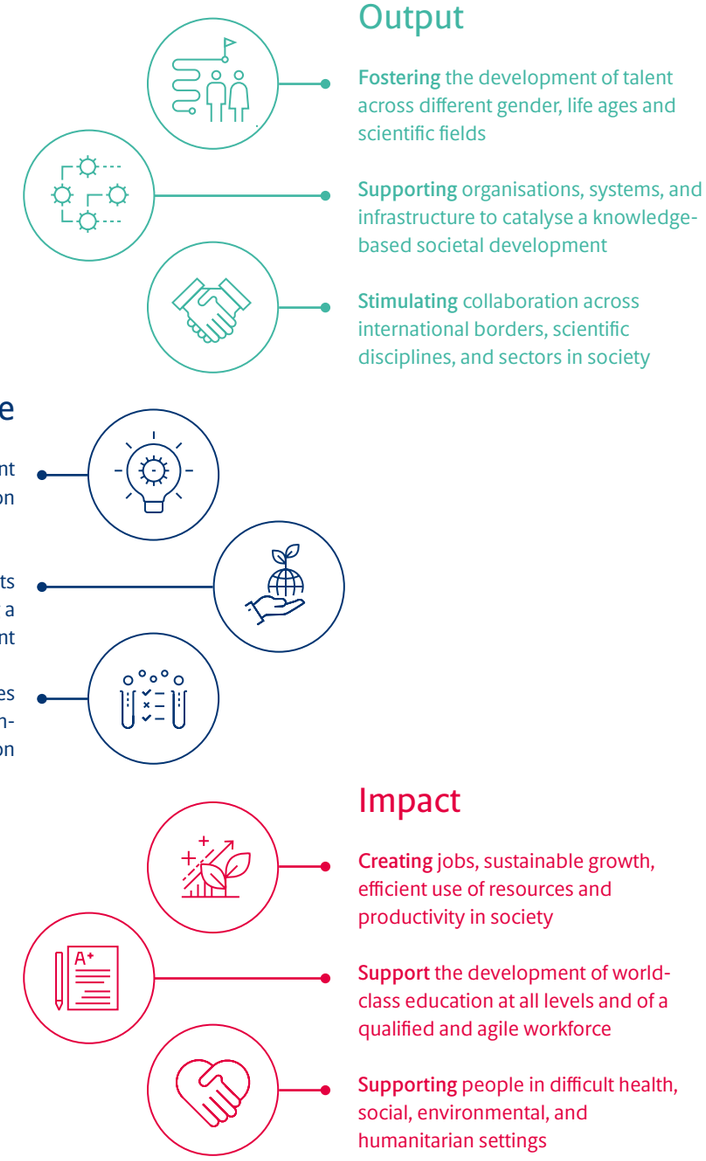
The principles help to guide the Foundation's activities. To live up to these principles, the Foundation uses a broad range of grant-giving models and instruments as well as commercial activities.

Our results in this report are based on extensive research and build on analyses of several data sources. We track the activities from our input and assess output, outcome and impact to monitor and analyse the societal impact of the portfolio of activities.

We use the reporting of the grant recipients and the companies, alongside other databases. We capture quantitative and qualitative data systematically in our two reporting systems, Researchfish® and Foundgood, and from surveys and research.

The Foundation aims to make contributions that benefit people and society

The societal impact principles for the Foundation



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Chapter 4

Learnings from philanthropic practice

Chapter 1 describes the monetary flows and the capital stock of the Novo Nordisk Foundation Group and how we contribute to research investments in society. The key insights for the year 2021 are:

- 13% of all public research and 23% of all private research in Denmark are financed by the Group.
- 14% of corporate taxes and 1.3% of direct personal taxes in Denmark were paid by the Group.
- The Foundation had a net worth of DKK 697 billion (EUR 94 billion) and awarded grants for a total of DKK 8.8 billion (EUR 1.2 billion), placing it in the world top-three when it comes to philanthropic activities.
- The sum of the Novo Nordisk Foundation Group's investments in R&D in the public sector as well as in the private sector is for 2021 estimated at 0.56% of Denmark's GDP.

Chapter 2 describes the societal impact of our grant-giving activities. Over nine sections, each devoted to a societal impact principle, we document our main imprints on society. The key results for the year 2021 are:

- More than 6,400 people in science have been fully or partly funded. Of these, 2,600 were PhD students and postdoctoral fellows.
- 8% of Danish journal articles were funded by the Foundation's grants. 68% were published by international teams, and 12% were published with co-authors from the industry. 23% were among the 10% most cited in the world.
- 740 jobs have been created in the 129 spinouts reported by grantees, of which 76 were established in the period 2017–2021.
- Since 2016 more 148 patent applications or patents, 93 clinical trials and 216 medical products and services have been based on Foundation grants.
- In 2021, more than 27,000 patients were treated at the Steno Diabetes Centers in Denmark.

Chapter 3 documents the societal impact of our corporate activities. We have analysed the Novo Group and Novo Holdings' life science portfolio of companies. The key societal impacts for the year 2021 are:

- 145,000 people are employed in the Novo Group (Novo Holdings, Novo Nordisk A/S and Novozymes A/S) and the 135 other companies in the life science portfolio.
- Since 2018, more than 13,800 patent applications have been published and more than 2,500 patents have been granted. 20% of Danish patents are granted to the Novo Group and portfolio companies.
- Between 61,000 and 103,000 people have been enrolled in 471 active clinical trials of a given year in the period 2017–2021.
- There are 40 million users of medical products (22% increase compared to 2020), more than 40 million users of medtech products and 640 million health tests (28% increase compared to 2020).

Chapter 4 provides a quantitative comparison of input, outputs and outcomes for selected research funding instruments. This analysis provides the first step towards substantiating qualitative judgements with data to support the learnings from our philanthropic practice.

- The first result is that the distribution of reported results across project grants is skewed. Either the ideas work, in which case they are a great success, or they do not work, in which case little is produced. 88% of research project grants report journal articles which suggest project grants are fulfilling their intended aim of allowing promising and novel ideas to be tested based on small amounts.
- The second result documents that different grants producing different balances of type of reported results confirming that there is a trade-off between advancing scientific knowledge and applying that knowledge in the design of funding instruments.

Chapter 1

The monetary contribution to society

The Novo Nordisk Foundation Group[1] contributes to society in many ways. It awards money to support public research for the benefit of people and society, pays taxes, develops solutions, and employs people.

Through the Novo Group (Novo Holdings, Novo Nordisk A/S and Novozymes A/S), investments in life science companies and capital investments, the Foundation Group contributes to private-sector research and innovation. Both these forms of engagement in society generate jobs, tax revenue in Denmark and abroad and contribute to the creation of income for more than hundred thousand people.

Underpinning all these benefits is the financial resilience and scale of the Foundation Group and its investments, which are covered in this chapter. We outline our legal and corporate structure, before describing the economic scale of our activities.

[1] Novo Nordisk Foundation Group consists of the Novo Nordisk Foundation, the Novo Group as well as Novo Holdings A/S' life science and capital investments. The Novo Group comprises Novo Nordisk A/S, Novozymes A/S and Novo Holdings A/S. Novo Holdings A/S is an investment company fully owned by the Novo Nordisk Foundation.

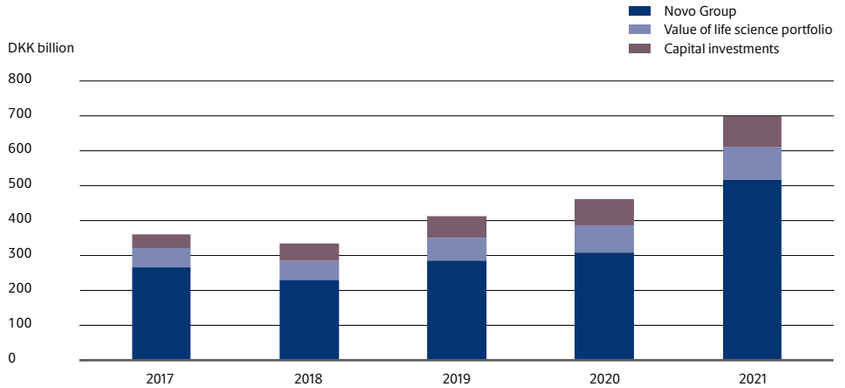
1.1 The business model

In 2021, the Novo Nordisk Foundation Group held investments in 137 life science companies and more than 200 other companies through its wholly owned subsidiary Novo Holdings A/S, a holding company and majority shareholder of Novo Nordisk A/S and Novozymes A/S. Novo Holdings manages the Foundation's commercial activities, which are primarily within life sciences, in addition to receiving dividends from Novo Nordisk and Novozymes and returns on its own commercial and financial investments.

The Foundation receives income from Novo Holdings and awards grants to benefit society. In 2020 and 2021, the Foundation had a net worth of DKK 457 billion and DKK 697 billion, respectively, making it one of the largest financial endowments of any foundation in the world. The income and the return on the investments in Novo Holdings was DKK 37 billion in 2021 compared to DKK 29 billion in 2020.

Figure 1.1.1 shows the composition of the financial endowment of the Foundation (investments in the Novo Group and all investments in life science companies and capital investments).

Figure 1.1.1 Development in the Foundation's financial endowment, 2017–2021 (DKK billion)

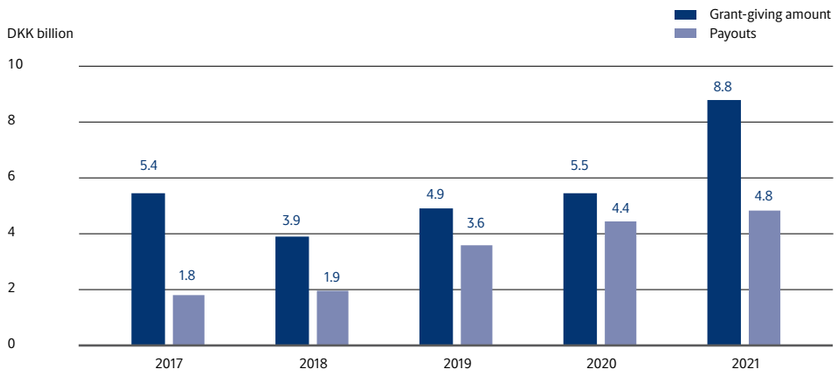


Source: Novo Nordisk Foundation.

1.2 Grant-giving for scientific and non-scientific purposes

The Foundation awards grants both for scientific purposes and non-scientific purposes. In 2021, the Foundation awarded 617 new grants worth DKK 8.8 billion (€1.2 billion), while it paid out DKK 4.8 billion (€640 million) on all active grants (see Figure 1.2.1). This was the highest annual grant amount and payout in the history of the Foundation. In 2017–2021, 80%–90% of the total payouts went directly to financing research and development in the public sector. In 2021 alone, the direct payments to public sector research and development activities as well as to research equipment and buildings, mostly at universities and research hospitals, totalled DKK 4.6 billion. DKK 3.6 billion went to research and development in Denmark. DKK 0.2 billion was paid out for non-scientific purposes.

Figure 1.2.1 Development in grant-awarding amount and payouts, 2017–2021 (DKK billion)



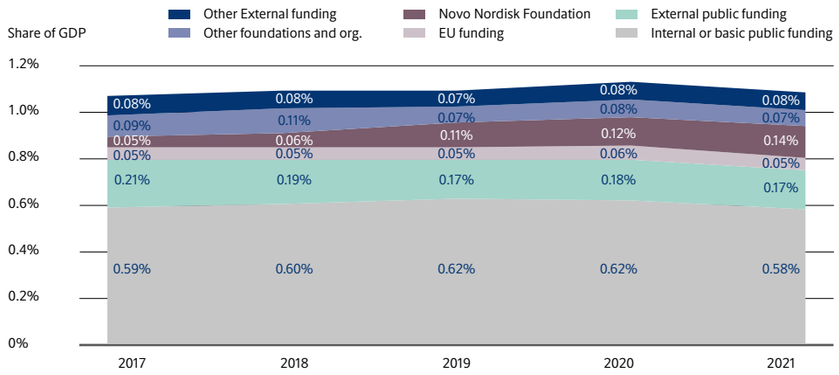
Source: Novo Nordisk Foundation.

1.3 Contribution to public and private research investments in Denmark

Public research and development

The Foundation contributed with an estimated 0.14% of GDP equivalent to 13% of public sector research funding in Denmark in 2021 (see Figure 1.3.1). We have estimated our contribution to 31% of public research spending in Denmark in 2021 within the biomedical and health sciences, 4% within the natural sciences, 2% within engineering/technical sciences and 1% within the humanities (the Foundation funds art and art history research) and social sciences (incl. health economic research).

Figure 1.3.1 Public research and development expenditure and by financing source (% of GDP)



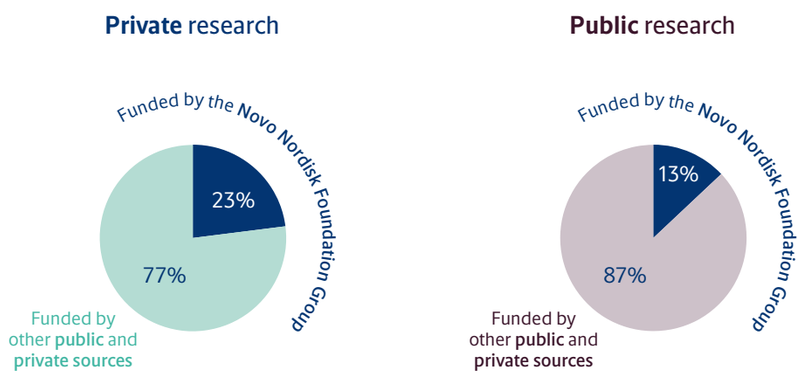
Sources: Universiteternes Statistiske Beredskab; Novo Nordisk Fonden.

The Foundation is one of many private foundations supporting public research in Denmark. Other foundations' and organisations' total share corresponds to 0.07% of GDP in 2021. The EU´s share is 0.05% of GDP.

Private research and development

The share of the Novo Nordisk Foundation Group companies' expenditure for R&D in the private sector in Denmark is estimated to 23% for the year 2021 (see Figure 1.3.2). This corresponds to 0.42% of GDP. The sum of the Novo Nordisk Foundation Group's investments in R&D in the public sector as well as in the private sector is for 2021 estimated at 0.56% of GDP.

Figure 1.3.2 Research and development investments in Denmark 2021



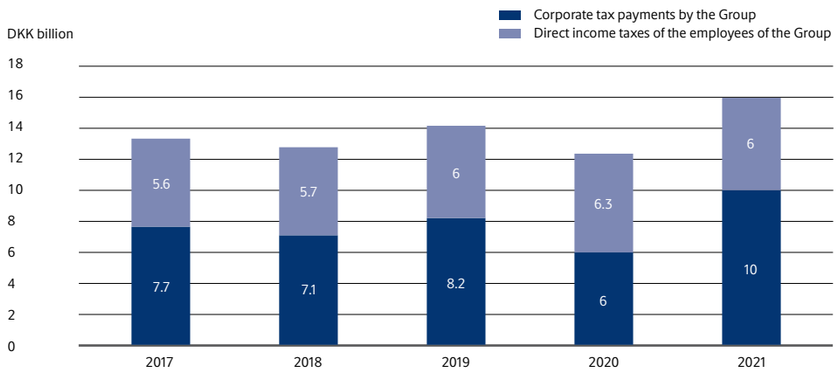
Sources: Universiteternes Statistiske Beredskab; Novo Nordisk Fonden.

1.4 Tax payments to Danish society

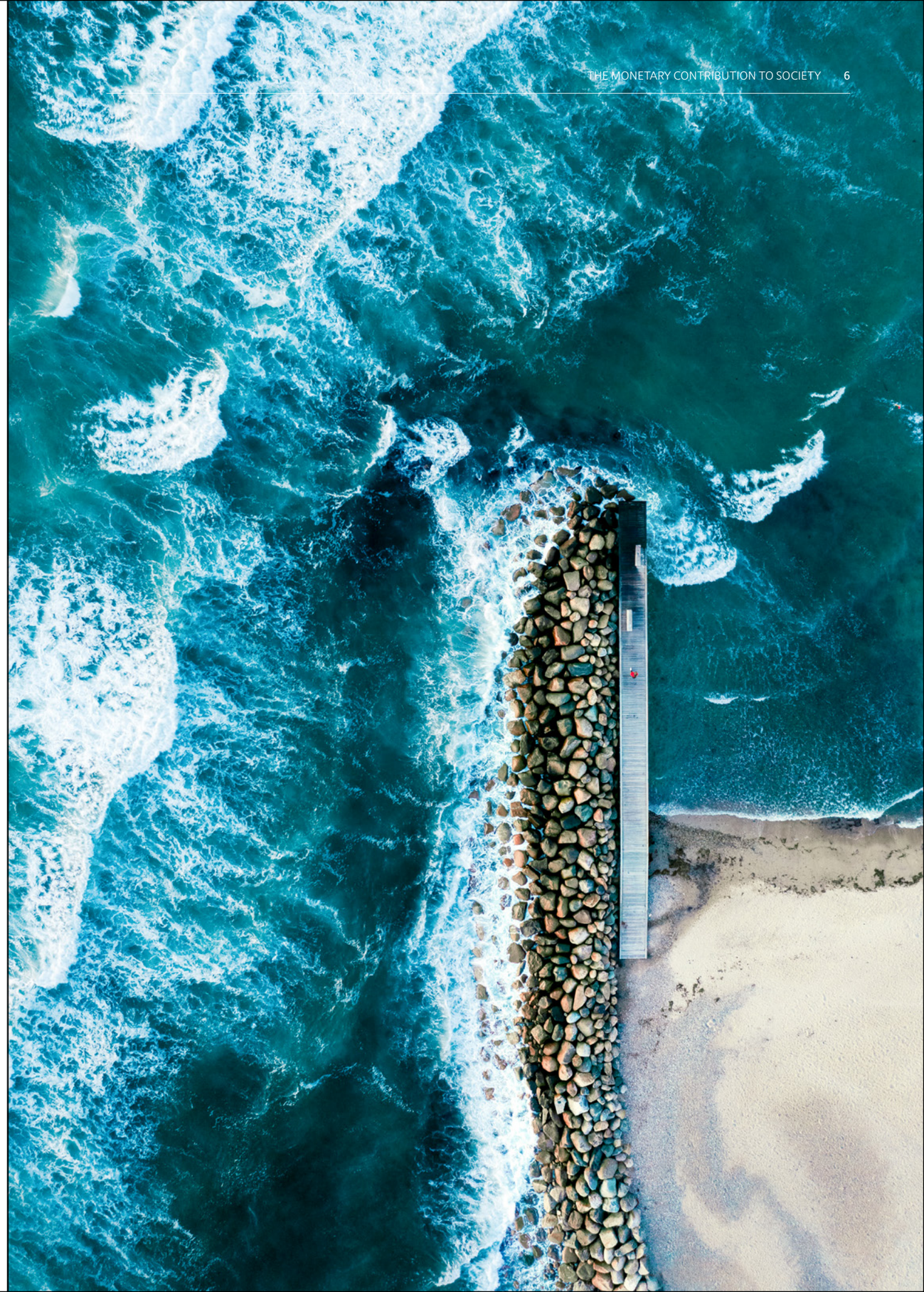
Through its economic activities, the Novo Nordisk Foundation Group contributes to significant tax income. Alone in Denmark, the total annual corporate tax payments amounted to DKK 10 billion in 2021 (Figure 1.4.1), which corresponds to approximately 14% of Danish corporate taxes. This is an increase compared to 2020 where the Group paid 10% of Danish corporate taxes. The figure also shows the Danish direct income taxes paid by the employees from the Novo Group and the life science companies where Novo Holdings' ownership share ranges between 5% and 100%. The direct tax payments were DKK 6 billion in 2021. The share of total Danish direct income taxes varies between 1.3%–1.4% between 2017 and 2021.

The total sum of the Group's corporate taxes and direct taxes of the Novo Group's and the life science companies' employees in Denmark was DKK 16 billion (€2.2 billion) in 2021 compared to DKK 12.3 billion (€1.65 billion) in 2020 (Figure 1.4.1). In addition to the corporate taxes and the direct taxes paid by the Novo Nordisk Foundation Group's employees, the companies and employees also pay indirect taxes. On top of that, the grant-giving activities of the Foundation also generate income taxes via income for people fully or partly paid by Foundation grants and employees in spinout companies based on Foundation grants (see section 2.6). The Danish society's tax income from the Group's activities will therefore be higher than the estimates in Figure 1.4.1.

Figure 1.4.1 The direct tax payments in Denmark of the employees and companies of the Novo Nordisk Foundation Group (DKK billion)



Sources: Novo Nordisk Foundation and Denmarks Statistics.



Chapter 2

The societal impact of philanthropic activities

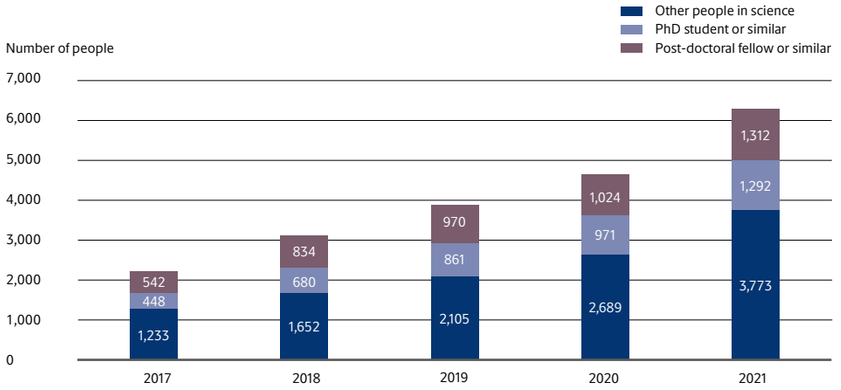
This chapter surveys the societal impact of the Foundation's grant-giving activities. It does this by systematically working through the nine principles of the Foundation's societal impact model.

2.1 Fostering the development of diverse talent

The first societal principle in the Foundation's impact model concerns developing of a talented and diverse population of researchers and helping institutions to attract talented researchers to Denmark. In 2021, the Foundation fully or partly funded nearly 6,400 people in science or research-hospital settings. In 2021, 21% of the people funded were Postdoctoral fellows, 20% PhD students while 59% held other positions in science.

The Foundation's funding helps to attract talented researchers to Denmark. This applies to almost half (47%) of the recruitments to Novo Nordisk Foundation research centres. Just over half of these (55%) are PhD students and postdoctoral fellows. In addition, other Foundation funding instruments attract research talent to Denmark, such as the Young Investigator Programme, RECRUIT, Start Package Grants and the Copenhagen Bioscience PhD programme for international students.

Figure 2.1.1 Number of people in science fully or party funded by the Foundation, 2017–2021



Note: Other people in science include assistant, associate, and full professors, as well as technical and administrative staff.
Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science.

PhD students and Postdoctoral fellows

Early career researchers are the future of the research ecosystem. The number of current PhD students and Postdoctoral fellows fully or partly funded by Foundation grants has grown to more than 2,600 in 2021, up from around 1000 in 2017 (Figure 2.1.1). The Foundation supports the research education of PhD students' and Postdoctoral fellows through a variety of grant instruments, including fellowships, research centres, PhD academies and PhD programmes and team member-funding through investigator grants and research projects and programmes. During 2018-2020, the fraction of all PhD students in Denmark fully or partly supported by the Foundation has increased from 7.4% in 2018 to 10.2% in 2020.

Gender distribution among researchers supported by the Foundation
In 2021, around 6,400 people in science were fully or partly funded by the Foundation's grants. 51% were men and 49% were women. The proportion of women at the lower seniority levels exceeded 50% and gradually falls as seniority increases, reaching 21% at the professor level. This reflects the situation at the universities in Denmark. The Foundation has adopted a diversity policy that aims to support diversity among grant recipients and to ensure equal opportunities and treatment for all applicants.

2.2 Supporting organisations, systems, and infrastructure

High-quality research thrives, and high-quality healthcare and education are delivered when researchers, doctors, nurses, healthcare professionals, and teachers have access to high-quality organisations, systems and infrastructure, access to the right people, and modern equipment and technologies. Such conditions for success make up systems and infrastructure and are part of a virtuous cycle: high-quality infrastructure attracts talented researchers and healthcare professionals providing attractive possibilities and stability. Since 2007, the Novo Nordisk Foundation has continuously funded a wealth of larger initiatives designed to facilitate advancements in education, research, innovation, and healthcare for the benefit of society.

In 2007–2021, the Foundation has awarded DKK 23.5 billion (€3.3 billion) to organisations, systems and infrastructure initiatives. It awarded DKK 5 billion in 2021 alone for new research centres, education academies and innovation initiatives. The Annual Impact Report 2020 from last year showed the activities of the many different types of organisations, systems and infrastructure initiatives supported.

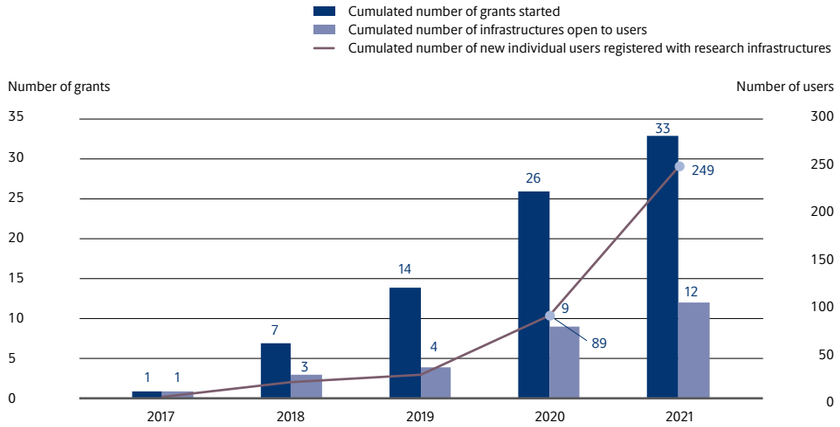
The Novo Nordisk Foundation grants for research equipment for existing facilities vary from DKK 6 million to DKK 255 million, and for research centres from DKK 100 million to DKK 2,300 million. Grants for health organisations, systems and infrastructure, including research hospitals, test facilities, data centres and the National Genome Centre under the Ministry of Health, varies between DKK 100 million and DKK 3,000 million. Grants for organisations and systems supporting education varies from DKK 28 million and up to DKK 1,900 million (LIFE Foundation). Finally, the Foundation has established BioInnovation Institute (BII Foundation) with a grant that might reach DKK 3,500 million.

Research infrastructure grants
A growing stream of research infrastructure grants for equipment, facilities and staff was kicked off in 2017 with the DKK 60 million (EUR 8 million) cryogenic electron microscope project (Cryo-EM) to boost the state-of-art of in electron microscopy techniques offered in the Core Facility for Integrated Microscopy at the University of Copenhagen (https://cfim.ku.dk/). In 2018 followed the first open calls offering grants of up to DKK 25 million (EUR 3.5 million). Six projects were funded ranging from DKK 6.6 million (EUR 0.9 million) for a biomolecular simulations infrastructure at Aarhus University (ROBUST) to a DKK 23.4 million (EUR 3.3 million) nuclear magnetic resonance spectroscopy facility at the University of Copenhagen (cOpenNMR).

Research infrastructure grants differ from research grants and research centre grants as they are completely focused giving researchers access to the infrastructure needed to achieve excellence in research and innovation. Applicants can apply for fully funded infrastructure projects, including procurement and instalment of equipment, building or developing facilities, as well as hiring and training of technical specialist teams to best service the infrastructure and its users.

By the end of 2021, the Foundation had awarded DKK 563 million to 33 research infrastructure projects of which 31 were awarded in open competition, while the Cryo-EM project (DKK 60 million) and the Proteomics Research Infrastructure (PRI; DKK 100 million) were awarded as stand-alone grants. These are all sizeable projects, typically with a one to three-year implementation phase during the five to seven-year project period. This can be seen in Figure 2.2.2, which shows that the number of infrastructures open for use trails behind the number of granted infrastructures. The number of users benefitting from the availability are growing fast as more infrastructures open up and in their second year reach more users. By 2021, 249 new users were reported to have registered research projects with the infrastructures. The current users represent approximately 2,000 researchers.

Figure 2.2.2 Development in the number of research infrastructure grants and availability for users



Sources: Novo Nordisk Foundation/Researchfish®/Infrastructure Reporting/Impact-of-Science.

2.3 Stimulating collaboration

The third key output from our impact model is enhanced collaboration. This section details the collaborative nature of the research supported by the Foundation. Collaborations can transcend geographical borders, involve both public and private researchers and build bridges between disciplines and genders. The data shows that researchers supported by the Foundation are involved in more international and industry collaborations than other researchers in Denmark. In addition to this, the level of interdisciplinary co-authorship in Foundation-funded articles is high.

National and international co-authorship in academia

In the period 2017-2021, 68% of articles authored by Foundation-supported researchers are co-authored with international researchers (Table 2.3.1). This is slightly higher than the 61% share of international co-authorship among all Danish articles published between 2016 and 2019 (the most recent data available - www.leidenranking.com). The rate of international co-authorship has been steadily increasing from approx. 50% in 2007-2012, but has recently plateaued.

Table 2.3.1 Number of Foundation-funded journal articles with co-authorships, 2017–2021

Academic co-authorship	Number of journal articles	% of journal articles
With international research institutions	10,011	68%
With other national research institutions	4,694	32%
Total	**14,705**	**100%**
Co-authorship with industry	1,745	12%

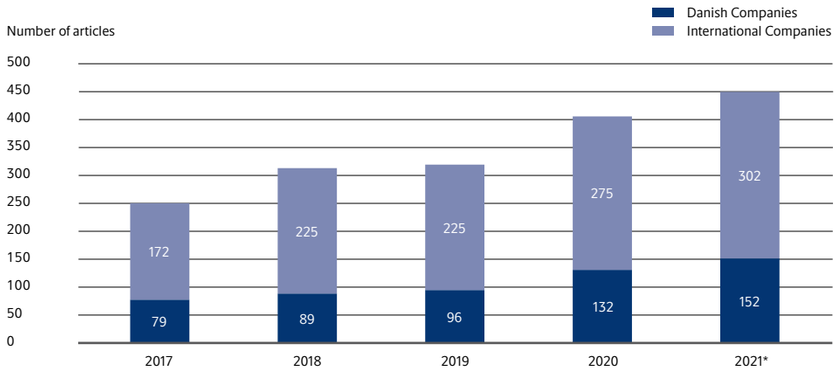
Note: The articles categorised as 'co-authored' in Dimensions include: 1) articles co-authored with researchers from two or more national research institutions only, and 2) articles co-authored with researchers from international, academic research institutions.
Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science, Digital Science Dimensions and DAMVAD Analytics.

Research co-authorship with industry

Collaboration across national boundaries is often seen as a measure of success. Similarly, co-authorship between academic researchers and those based in industry is valuable, as it points towards collaborations that may move new knowledge into commercial application. Of the Foundation-supported journal articles published by grant recipients between 2017 and 2021, 12% (1,745 articles) were co-authored with industrial researchers. The share is above the average share (10%) for all Danish journal articles published between 2016–2019 within biomedical and health sciences, (www.leidenranking.com), as well as above the average share (7%) of the OECD countries' journal articles. 60% of the articles concerned medical and health sciences, while one third of the articles co-authored with industry researchers were within the chemical and biological sciences. In comparison, the share of grants awarded within the medical and health sciences and biological sciences is 37% and 28% respectively.

The number of journal articles co-published with industrial researchers has increased from 251 in 2017 to 452 in 2021. Similarly, the number of different companies co-publishing with grant recipients has also increased, from 192 in 2017 to 282 in 2021. Figure 2.3.1 shows that this growth has largely come through co-publication with international companies. Around 80% of the collaborating companies are international, and the split remains largely the same between 2017 and 2021.

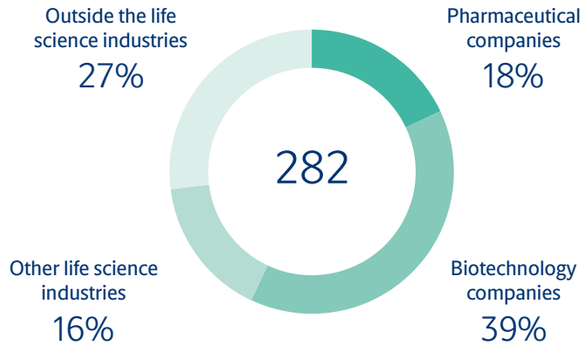
Figure 2.3.1 Number of journal articles co-authored with company-affiliated researchers distributed by origin of the company



Note: *) Preliminary estimate. The actual figure is likely to be higher, since every year in January grant recipients also report publications previously omitted.
Sources: Novo Nordisk Foundation/Impact-of-Science and DAMVAD Analytics.

Figure 2.3.2 shows the distribution of the Foundation-funded, company co-authored journal articles across industry sectors. In 2021, the share of articles co-authored with researchers from the life science industry was 73%. Half of the life science industry-academia articles were co-authored with industry researchers from biotechnology companies, an increase of 2%-points from the previous year.

Figure 2.3.2 Number of company co-authored journal articles



Note: Preliminary estimate. The actual figure is likely to be higher, since every year in January grant recipients also report publications previously omitted.
Sources: Novo Nordisk Foundation and DAMVAD Analytics.

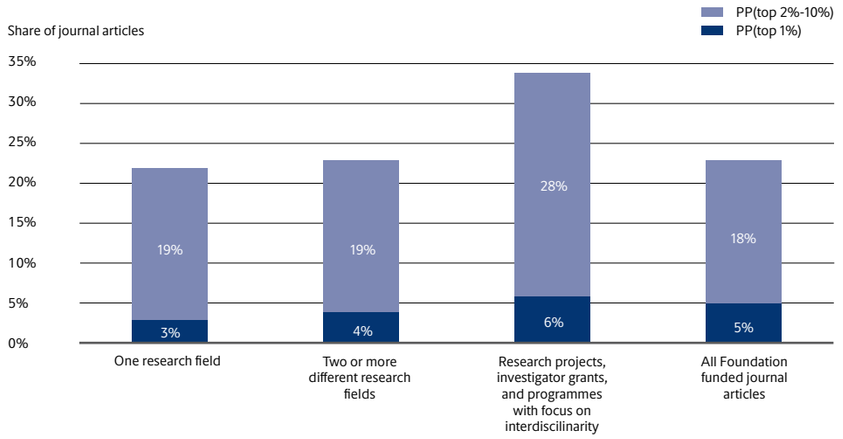
Interdisciplinary co-authorship
Similar to international co-authorship and co-authorship with industry, collaboration between disciplines is often valuable because it brings additional perspectives to bear and synergies. By examining co-authors' background, journal articles can be classified as monodisciplinary or interdisciplinary. Interdisciplinary co-authorship can link relatively closely related disciplines or reach across a wider spectrum of science. The level of interdisciplinarity used here is based on the researchers' finely grained academic specialisations, such as endocrinology, microbiology, genetics, physiology, biotechnology, physics, chemistry or bioinformatics, which are merged at the higher level of the OECD fields of science, like medical and health sciences, natural sciences, engineering and technology, or social sciences and humanities.

The analysis shows that the Foundation's dedicated interdisciplinary research grants are succeeding in promoting interdisciplinary co-authorship. Taking a random sample of 20% of the Foundation-funded journal articles for each year between 2017 and 2021, we find that 64% of the articles have been published by authors from 2–4 fields of science. In contrast, the output from our dedicated interdisciplinary grant instruments shows that 81% of the journal articles have authors from 2–4 fields of science.

Citation impact of interdisciplinary co-authorship
Citation analysis suggests that support of interdisciplinary collaboration produces high quality research. One indicator for the impact of the journal articles by Foundation-funded researchers is that they are consistently overrepresented in the top 1% and top 10% most cited publications (as detailed in section 2.4). The scientific literature (e.g. Lin Zhang, et al, On the relationship between interdisciplinarity and impact: Distinct effects on academic and broader impact, Research Evaluation, 2021) suggests that a greater diversity of disciplines involved in a research project, increases the likelihood of it achieving novel research findings and being highly cited.

Our findings for Foundation-funded journal articles confirms that articles with authors from more than one field of science are likely to be more highly cited. However, all subsets of publications from Foundation-funded researchers are overrepresented in the proportion of publications within top 1% (PP(top 1%)) and top 10% (PP(top 10%)) most cited journal articles (Figure 2.3.3). Journal articles co-authored within two or more different research fields have an even higher share among the top 1% or 10% most cited. And finally, for journal articles published in conjunction with research projects and programmes with a particular focus on interdisciplinarity, the results confirm the hypothesis that a higher degree of interdisciplinarity gives a higher probability of producing articles that are among the most cited in their field. Figure 2.3.3 shows a PP(top 1%) and PP(top 2%-10%) of 6% and 28%, respectively, 2017–2020, for Foundation funded articles. The figure shows both the citation impact by number of fields of science and for all Foundation funded articles.

Figure 2.3.3 PP(top 1%) and PP(top 2%-10%) for Foundation-funded journal articles, 2017–2020

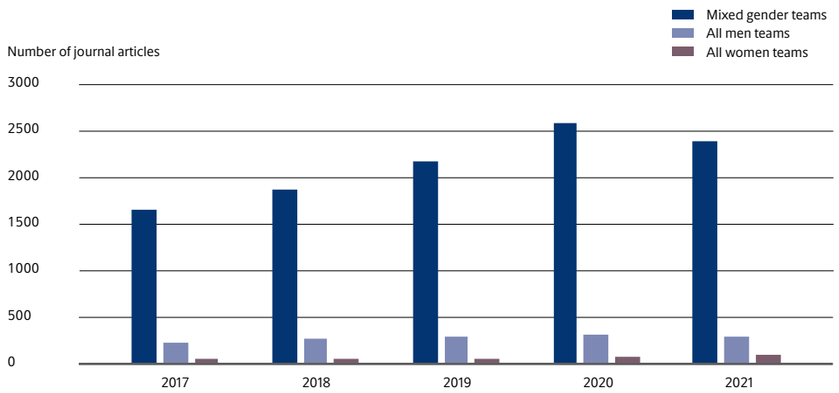


Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science, Digital Science Dimensions and DAMVAD Analytics.

Gender balance co-authorship

The gender balance co-authorship in journal articles is a new metric of collaboration[2]. Figure 2.3.4 shows that most of Foundation-funded research papers published by mixed gender co-authors. The Foundation-funded journal articles have on average 8 co-authors. The share of women in co-authored Foundation-funded journal articles was 37% in 2021 up from 34% in 2017.

Figure 2.3.4 Gender co-authorship in co-authored Foundation-funded journal articles



Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science and Clarivate Analytics/Dimensions.

First and last authors are particularly significant in biosciences where custom dictates that the first and last authors usually are the persons who made the most significant contributions. Our analysis shows that the total number of Foundation-funded journal articles increases over time for both men and women as first or as last author. Furthermore, since 2017 the fractions of female authors as the first and as the last authors remain relatively stable around 40% and 30%, respectively.

[2] Nielsen M.W. et al. (2017). Gender diversity leads to better science. PNAS Vol. 114, No.8. https://doi.org/10.1073/pnas.1700616114

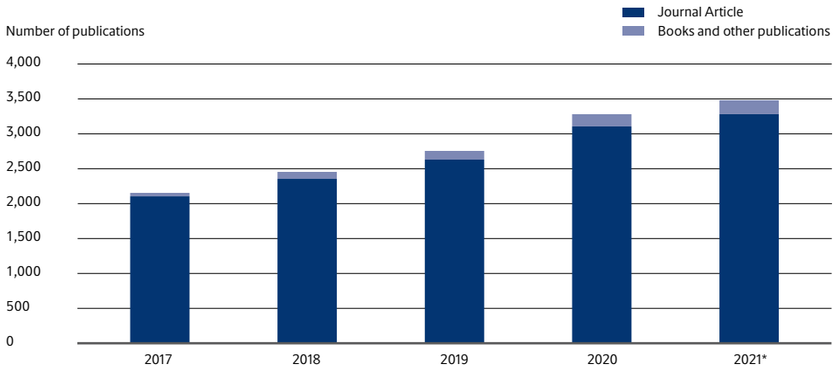
2.4 Promoting excellent research and innovation

The fourth societal impact principal of the Foundation is to promote excellent research and innovation. The level of research excellence is maintained in the Foundation-funded research as the breadth and scale of the research supported increases.

Foundation-funded research published in journal articles

The amount of research produced by Foundation grant recipients has continued to grow. In 2021, grant recipients reported 3,501 publications supported by the Foundation's funding. 3,300 of these were journal articles with the remaining 200 made up of a variety of other publications, including policy papers, technical reports, letters, books and book chapters (Figure 2.4.1). Because the recipients of Foundation grants typically obtain additional funding and multiple authors contribute to a publication, most publications are supported by more than one funder or more than one funding instrument of the Foundation.

Figure 2.4.1 Total number of publications by recipients of Foundation grants, 2017–2021



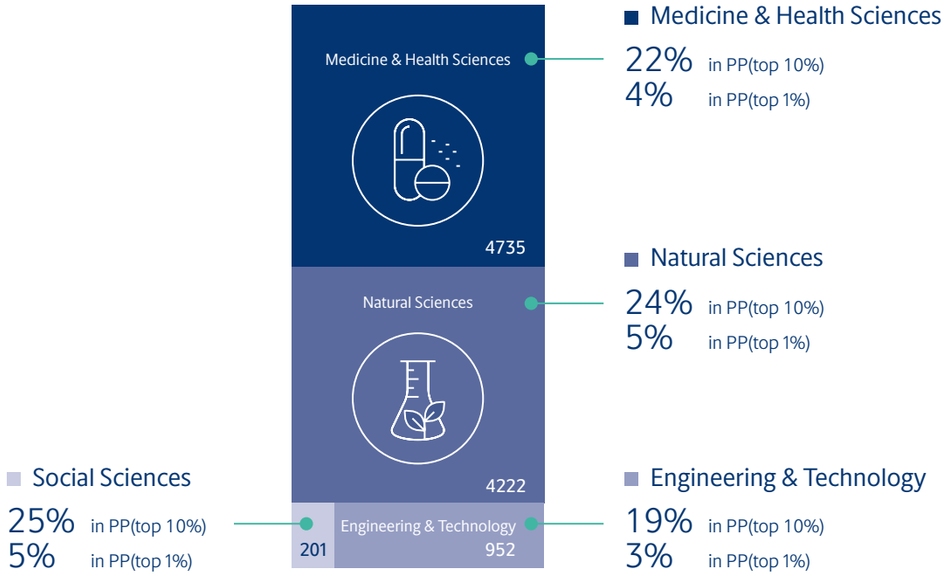
Note: *) Preliminary estimate. The actual figure is likely to be higher, since every year in January grant recipients also report publications previously omitted.
Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science and Dimensions.

Recipients of grants contributed to 8% of the articles published in Denmark, this is up from 7% in 2020. With a delay in grantees' reporting, the share is expected to be higher next year. In addition, the Foundation grants contributed to 0.6%, 0.5% and 0.2% of the journal articles published from Sweden, Finland, and Norway, respectively.

Overall citation impact of grant recipients journal articles
Citation levels give an indication of the rate of dissemination and use of Foundation-funded research in an academic context. For the period 2017–2020, 5% of the research was among top 1% of global research, and 23% of the journal articles are among the top 10% most frequently cited. In comparison, the fraction of all Danish journal articles among the top 10% most cited articles in the world was 17% for the same period.

The fields in which Foundation-funded research is published remains largely unchanged: 47% of the Foundation-funded journal articles refer to the medical and health sciences. 42% of the journal articles are within natural sciences and 9% are within engineering and technology. Overall, the Foundation grant recipients deliver high impact research within all supported fields of science (Figure 2.4.3).

Figure 2.4.3 Share of publications among the top 10% most frequently cited in the world – PP (top 10%), 2017–2020, and volume of publications, by OECD Field of Science and Technology



Note: Only includes areas with a total of 100 or more publications in the period.
Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science and Dimensions.

While more than 95% of the publications within medical science and natural and technical sciences are journal articles, the majority of the publications from the Foundation's grantees within humanities (e.g. research in art and art history) are books, book chapters, dissertations and other types of publications. The Foundation's grantees within humanities delivered more than 200 publications between 2017 and 2021, and within social sciences more than 230 publications.

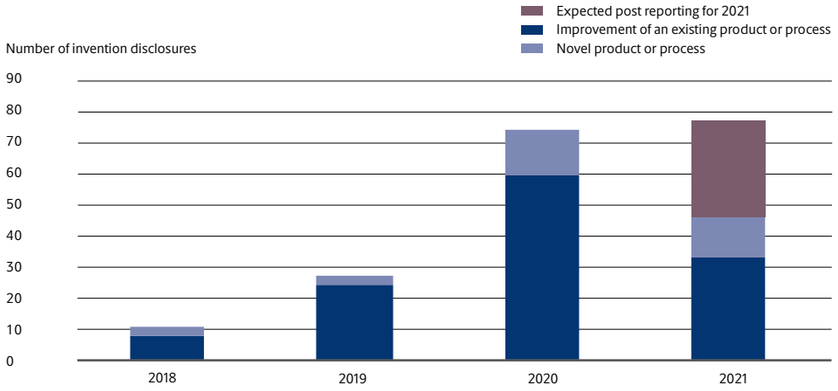
There are 4,735 Foundation-funded journal articles within medical and health science published during 2017–2020. 18% of the 1,247 journal articles published within Endocrinology, Diabetes & Metabolism are among the top 10% most cited in their field. 26% of the 870 journal articles published within Molecular Biology are among the world's top 10%.

2.5 Developing innovative products and solutions

The Foundation supports innovation activities at research institutions and dedicated innovation grants as well as through various research and education grant instruments. The innovation grants aim for commercialisation of research discoveries within life science.

Scientific discoveries and innovative solutions
Research supported by the Foundation feeds into the technological and commercial innovation process. One of the early steps on the road to commercialisation is when researchers file an 'invention disclosure' based on their new discovery at the research institution where they are based. Ownership and commercialisation rights for the invention are then negotiated and this allows for patent filing, which is often the next step in commercial exploitation. In 2021, grant recipients reported 47 invention disclosures, covering novel and improved processes and products (Figure 2.5.1). In 36 of these instances, the public research institutions have taken ownership of the invention, corresponding to 77% of the disclosures.

Figure 2.5.1 Invention disclosures, 2018–2021

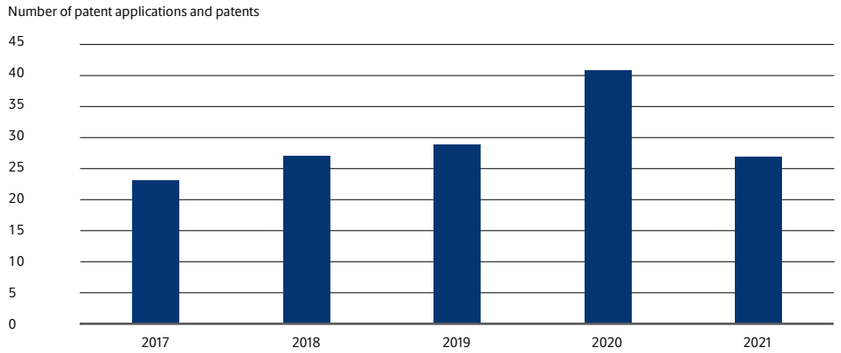


Note: Data on invention disclosures has been collected since 2020. There is an expected post reporting.
Sources: Novo Nordisk Foundation/Researchfish®.

Patent innovation activities based on Foundation-funded research

The Foundation grant recipients have reported 148 patent applications or granted patents for the period 2017–2021 distributed on 115 patent applications and 33 granted patents. Of these 148, 41 have been licensed. In 2021 alone, 19 patent applications and 8 granted patents were reported (Figure 2.5.2). The patent activity is distributed between the BioInnovation Institute, the Novo Nordisk Foundation research centres and other Foundation initiatives.

Figure 2.5.2 Patent applications and granted patents filed by grant recipients, 2017–2021



Note: There is an expected post reporting.
Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science.

Estimating the full extent of the use of published research results in inventions takes several years

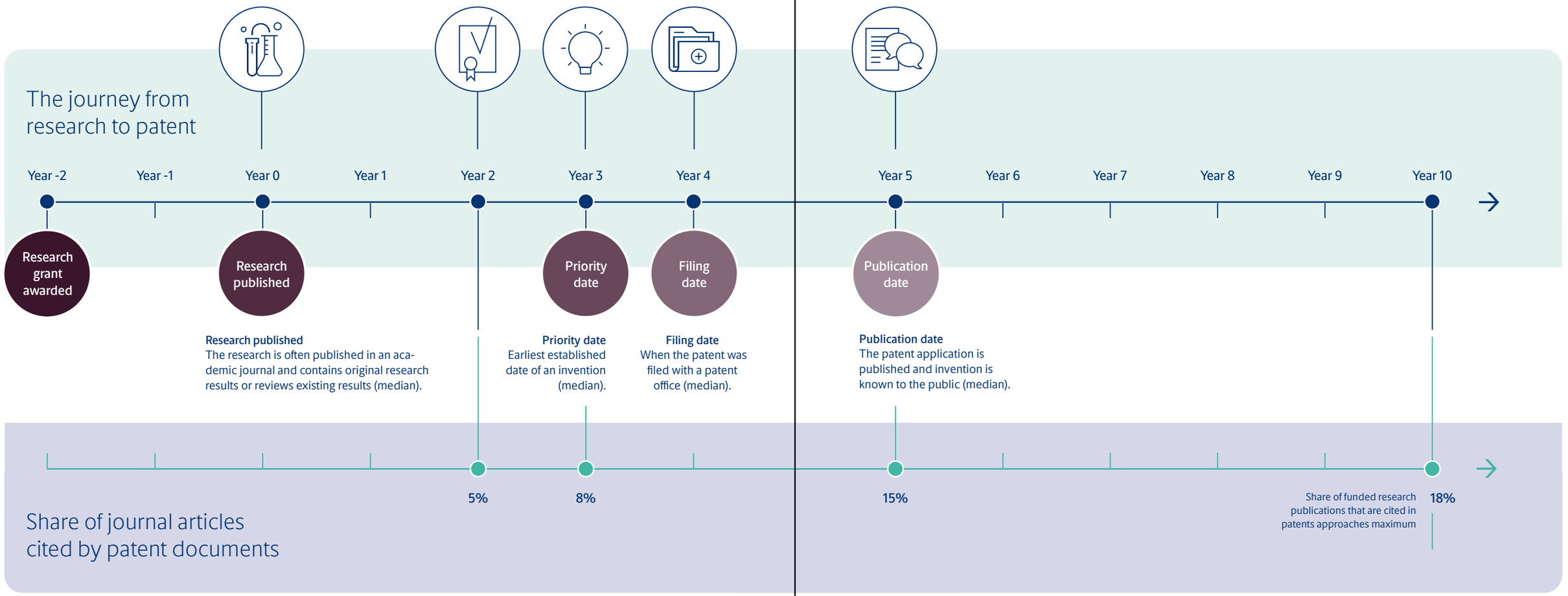
A second pathway from Foundation-funded research to commercial innovation is via use of research (citation of journal articles) in patent documents.

There are inherent time lags. The first lag that follows the initial knowledge production is a knowledge absorption time lag, measured as the time between the publication date of a journal article and the priority date of the referencing patent documents, which on average is three years.

Second, there is also a non-disclosure time lag because patent applications are only made public 1½ years after the date they are filed. Due to these time lags the percentage of Foundation-funded journal articles cited in patents increases over time.

Thus, the citation level appears to plateau for journal articles after nine years of their publication. When applying this timeframe, around 18% of Foundation-funded journal articles are cited in patent documents (Figure 2.5.3).

Figure 2.5.3 Patent citation timeline for public Foundation-funded research

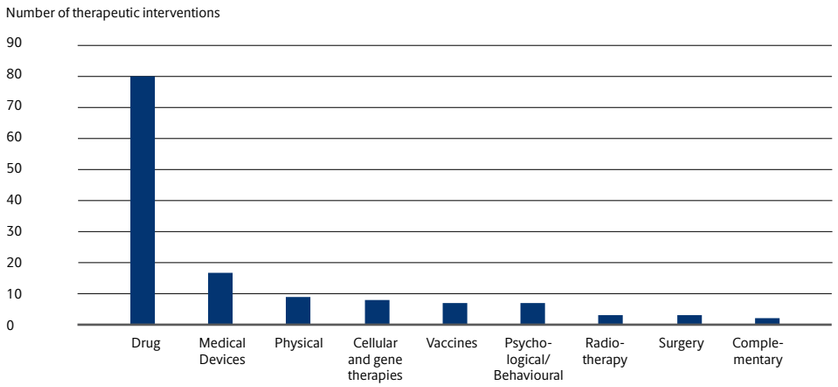


Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science; Dimensions (Google Big Query); EPO DOCDB.

Medical interventions and products based on grants

For the year 2021, the Foundation's grant recipients have reported 77 new products and medical interventions. Since 2014, 136 grant recipients have reported 216 medical interventions and products. Of the medical interventions reported 60% are therapeutic interventions that directly affect patients. Of these, 37% are drugs, 7% are medical devices, 4% are physical interventions, with the remaining 12% ranging across a variety of other types of therapeutic interventions (Figure 2.5.4).

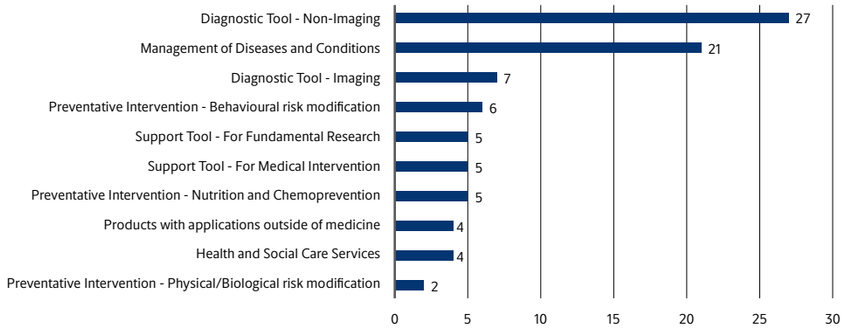
Figure 2.5.4 Therapeutic interventions reported by the Foundation's grantees



Note: Time period: 2014–2021.
Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science.

Through medical interventions and products, the Foundation's grants have a significant impact on health and patient care. Examples of medical products and interventions include diagnostic tools, tools to manage diseases and preventive interventions (Figure 2.5.5).

Figure 2.5.5 Number of other medical interventions and products 2014–2021



Note: Time period: 2014–2021.
Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science.

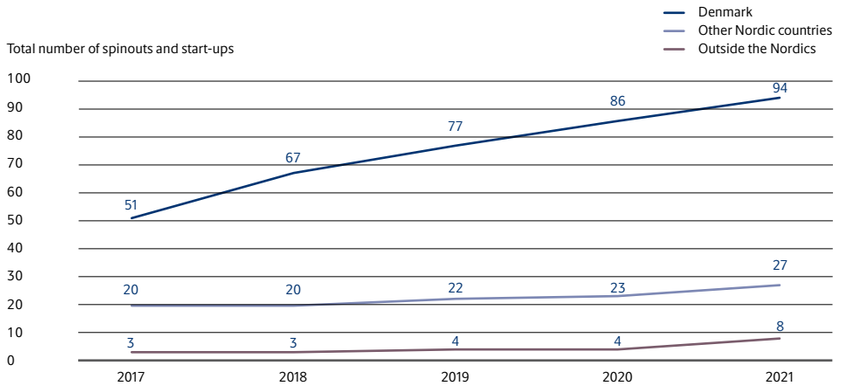
2.6 Creating jobs and growth

Investments in research, innovation, education and research hospitals also have impact and provide benefit to society through the creation of companies, jobs and economic growth. This section details the direct job generating effect of Foundation-funded activities covering spinout companies and employment through grants. The section takes it starting point in creation of spinout companies, followed by their impact on job generation, and finally assessing the impact and productivity of the companies in terms of their ability to attract additional funding.

Spinouts based on Foundation-supported research

New knowledge generated by Foundation-funded researchers can form the basis of innovation and new companies. These spinout companies are generally established by researchers based in universities or hospitals. The Foundation has had a specific stream of funding for innovation grants since 2007, which involves funding of early academic research, mentoring, proof-of concept grants, advice in commercialisation of research discoveries, follow-on investments and support for exits. The support is provided by the Foundation's innovation initiatives, including the Foundation-funded BioInnovation Institute (BII) and pre-seed grants from Novo Seeds.

Figure 2.6.1 Portfolio of spinouts and start-ups based on Foundation grants, 2017–2021

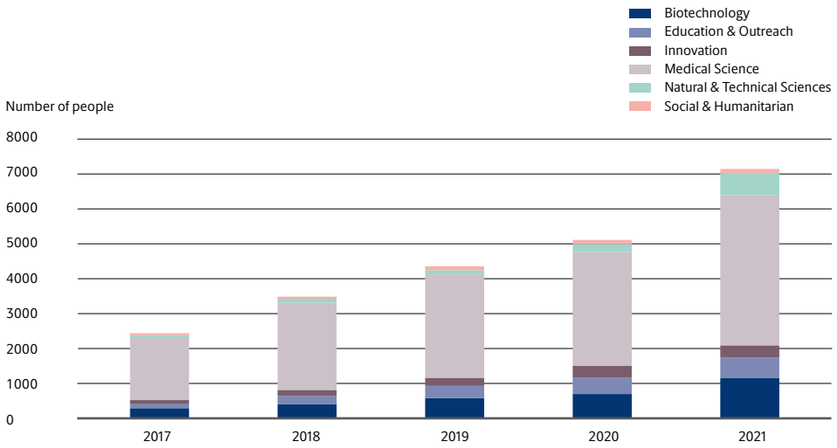


Source: Novo Nordisk Foundation.

Innovation and research grantees reported the establishment of 129 spinouts based on Foundation grants between 2007 and 2021, with around 60% being reported in the period 2017–2021. 94 spinouts have been established in Denmark, while 27 were established in the other Nordic countries and eight outside the Nordics (Figure 2.6.1).

Job creation
By the end of 2021, spinouts and start-ups based on Foundation-funded research account for 740 positions. Of the 740 jobs, 84% are in Denmark, 14% in the other Nordic countries and 2% in the rest of the world. In line with the increase in the Foundation's payouts, the number of people fully or partly funded by the Foundation's grants has increased from 2,400 in 2017 to 7,150 in 2021. In 2021, around 6,400 of these people were working in science, with 750 related to non-scientific grants.

Figure 2.6.2 People supported in all Foundation Funded grant-giving activities



Note: Jobs cover grantees, team members as well as staff at centres and institutes.
Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science.

Valuing innovation
The ability of Foundation grantees to attract additional funding for commercialisation is a key market-based indication of the value of their research projects. In the period 2007–2020 spinouts and start-ups have attracted more than DKK 7.4 billion (EUR 1 billion) in additional funding. For spinouts and start-ups that have raised additional funding this equals around five times the amount they have received from Foundation grants. This leverage demonstrates how a relatively small amount of capital, in combination with the network, infrastructure, knowledge, and help provided by BII, lead to attraction of further investment to these businesses and accelerate their growth.

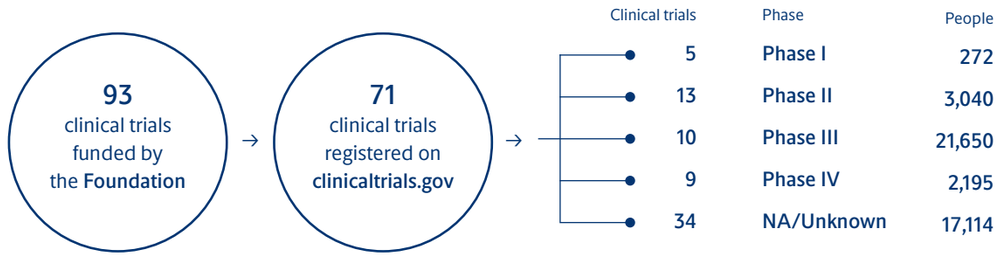
As an example, the first-time entrepreneurs founding the cancer treatment start-up Adcendo raised no less than DKK 380 million (EUR 51 million) in Series A financing for a start-up built upon a DKK 10 million (EUR 1.3 million) BII convertible loan. The financing that was led by Novo Seeds and Ysios Capital was the largest ever Series A for a Danish biotech company, when it was announced in April 2021.

2.7 Developing new technologies, therapies and disease prevention

This section shows that Foundation funded research contribute to clinical trials, clinical guidelines, patient care and many medical interventions and products.

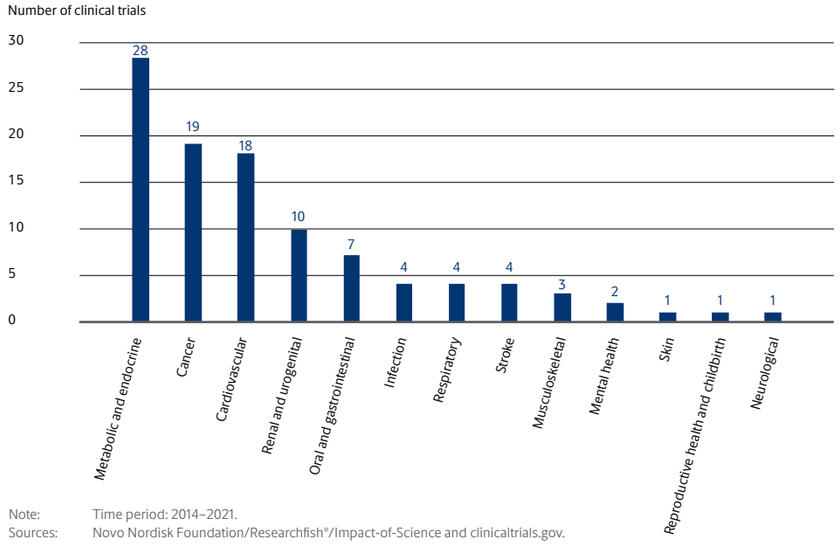
Clinical trials
The Foundation funds researchers who conduct investigator-initiated clinical trials. Grant recipients have reported a total of 93 clinical trials since 2014 (Figure 2.7.1), of which 71 are registered in the US registry clinicaltrials.gov (note that not all clinical trials have to be registered, especially in the early phase I, and they might be registered in a different clinical trial registry). 84% of the 71 clinical trials were conducted in Denmark. In total, 44,270 people are enrolled in these trials. Of the 71 clinical trials, 10% reported on biological sex and ethnic groups of the people participating in the clinical trials.

Figure 2.7.1 Clinical trials funded by the Foundation



Note: Time period: 2014–2021.
Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science.

Figure 2.7.2 Health categories for clinical trials



Note: Time period: 2014–2021.
Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science and clinicaltrials.gov.

The clinical trials reported by grant recipients are mostly within the Metabolic and Endocrine health category, which includes diabetes and obesity (Figure 2.7.2).

Clinical Guidelines
Clinical guidelines are systematically prepared scientific recommendations drawing together evidence from clinical trials and other research that support healthcare professionals in decision-making. The extent to which clinical guidelines cite research conducted by the Foundation's grant recipients is indicative of the relevance and significance of the research for patients.

Figure 2.7.3 The 428 contributions to practice guidelines and advisory functions in 2017–2021

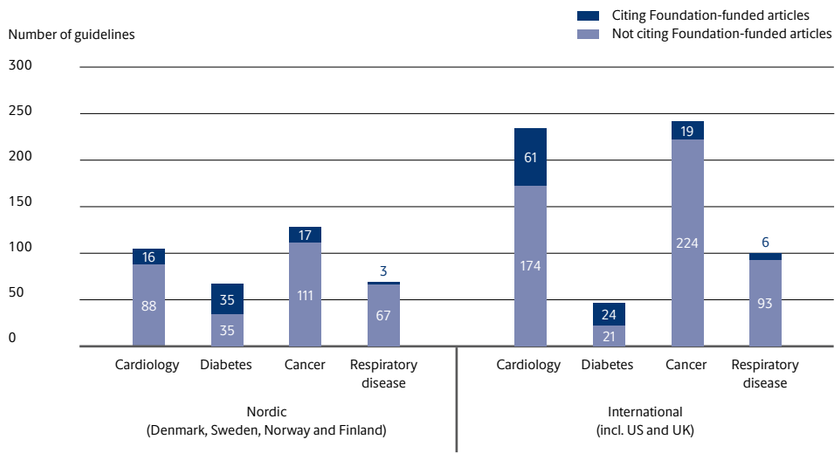
Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science.

Researchers contribute to improved patient care by developing and revising the clinical guidelines, drawing on their own and others' research. Grant recipients reported a total of 428 such contributions in the period 2017–2021. Of the contributions reported, 24% concern membership of a guideline committee, while 24% relate to participation in an advisory committee. Related activities are contributions to other policy documents and supporting training of practitioners or researchers. These various activities are broken down in Figure 2.7.3.

Many Foundation-funded journal articles are cited in guidelines on the treatment of patients within the four Non-Communicable Diseases (NCDs): diabetes, respiratory diseases, cardiovascular diseases and cancer. We analysed 991 clinical guidelines in current use. The data includes guidelines published between 2011 and 2021 in Denmark, the other Nordic countries, in the United Kingdom and the United States, and by international organisations such as the European Union and the World Health Organization (WHO). Clinical guidelines and recommendations for clinicians are continually updated with the latest achievements in research and new knowledge on patient care. Some are updated annually and others every 5–10 years.

Of these 991 guidelines, 181 cited Foundation-funded research articles, corresponding to 18% (Figure 2.7.4). There was no substantial difference in the share of guidelines citing Foundation-funded research articles according to geographical location (Nordic countries vs the rest of the world).

Figure 2.7.4 Clinical guidelines in different areas citing Foundation funded research (2011–2021)



Sources: Novo Nordisk Foundation and DAMVAD Analytics.

Clinical guidelines within diabetes
Historically, the Foundation has focused on diabetes and diabetes complications. The analysis shows that the number of diabetes guidelines increase by a factor three from 20 in the period 2012–2016 to 69 in 2017–2021. The share of guidelines that cite research published by the Foundation's grant recipients decrease from 65% in 2012–2016 to 49% in 2017–2021.

Clinical guidelines within cardiovascular diseases
The number of active guidelines remains comparable, but the share that cite articles by grant recipients almost doubled from the period 2012–2016 (20%) to 2017–2021 (37%), demonstrating the increased influence of Foundation-supported research within this area.

Clinical guidelines within cancer diseases
Our calculations show that the grant recipients contributed to 36 (10%) of the guidelines covering cancer, published in all the Nordic countries, the United Kingdom and the United States, as well as by international organisations. And further, the share of guidelines that cite articles by the Foundation's grant recipients more than doubled between 2012–2016 (5%) and 2017–2021 (12%).

Clinical guidelines within respiratory diseases
The number of clinical guidelines within respiratory diseases published by the public authorities in all the Nordic countries and internationally has increased by more than 100% between 2012-2016 and 2017-2021. Our calculations show that the grant recipients contributed to four (9%) of the guidelines covering the non-communicable respiratory diseases in 2012–2016 and to five (5%) in 2017–2021.

Documentation in patient quality databases
The Danish Clinical Quality Program (National Clinical Registries) facilitates the development and reporting of quality indicators and standards for good clinical practice to improve the overall quality of patient treatment in the Danish hospitals and medical practices. Of the 85 Danish clinical databases, 31 reports have published documentation of the evidence in reports with references to scientific literature (as of November 2021).

Documentation reports are a systematic overview of the scientific evidence behind the choice of indicator variables in the patient quality database and are important links between the discoveries published in scientific journals and patient treatment and outcomes. Of these 31 documentation reports, 14 cite Foundation-funded journal articles (45%). Of these 14, six are within cardiology, four within diabetes and cardiometabolic conditions, two within muscular-skelatal-organ disorders and one within cancer as well as within respiratory diseases.

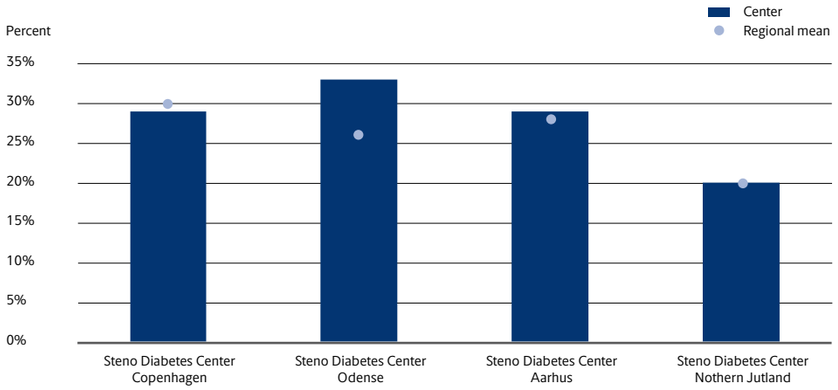
Number of people treated and quality of treatment at the Steno Diabetes Centers
The Steno Diabetes Centers aim to advance all aspects of diabetes care in Denmark across a patient's lifetime through a public–private partnership model. The Foundation funds new up-to-date diabetes hospital buildings, diabetes research, education of nurses and doctors and state-of-the-art care for diabetes patients. The aim of this modernisation is to boost the development of diabetology and increase the life expectancy and quality of life for people with diabetes in the Danish Realm. The Centres provide a wide range of healthcare services related to diabetes, including diagnosis, treatment, eye scanning and examination, podiatry, dietary guidance supplemented by tuition in a food laboratory.

The number of patients treated by the Steno Diabetes Centers has continued to increase. The total number of people treated was approximately 7,000 in 2017, and by the end of 2021 more than 27,000 people were treated.

Certain factors are considered essential to achieving optimal patient outcomes. In diabetes, this includes e.g. glycaemic control and control of blood lipid levels. High blood glucose levels (i.e. poor glycaemic control), and high levels of LDL cholesterol are all factors that increase the risk of diabetic complications and comorbidities, e.g. cardiovascular diseases and amputations. The quality of patient care is measured using these and other indicators. Using data from The Danish Clinical Quality Programme, the Steno Diabetes Centers' patient treatment can be benchmarked against the treatment provided at other Danish hospital wards.

Figure 2.7.6 a Patient care in the Steno Diabetes Centers benchmarked against other Danish hospital wards

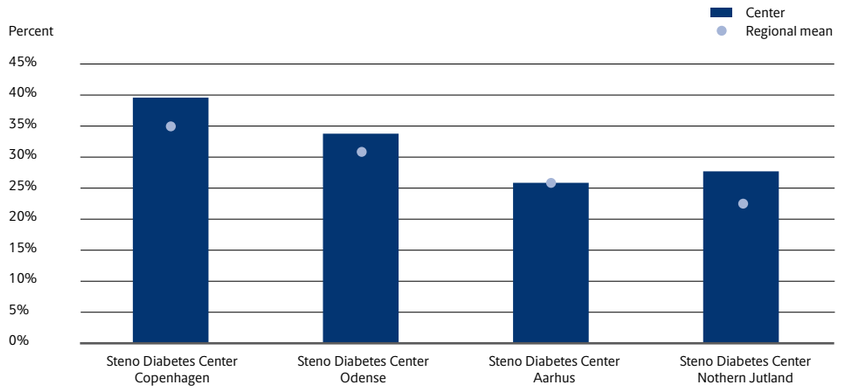
Good glycemic control (percent with HbA1c <= 53 mmol/l) among patients with Type 1 diabetes treated at Steno Centers and in Danish hospitals in general



Sources: Novo Nordisk Foundation and the Clinical Database for Diabetes in The Danish Clinical Quality Programme.

Figure 2.7.6 b Patient care in the Steno Diabetes Centers benchmarked against other Danish hospital wards

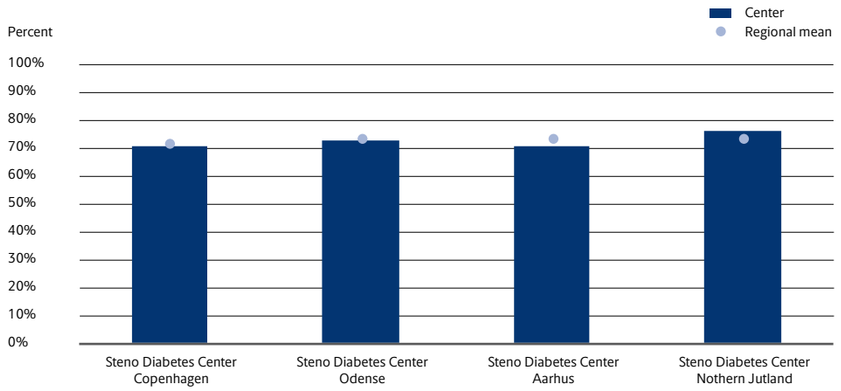
Good glycemic control (percent with HbA1c <= 53 mmol/l) among patients with Type 2 diabetes treated at Steno Centers and in Danish hospitals in general



Sources: Novo Nordisk Foundation and the Clinical Database for Diabetes in The Danish Clinical Quality Programme.

Figure 2.7.6 c Patient care in the Steno Diabetes Centers benchmarked against other Danish hospital wards

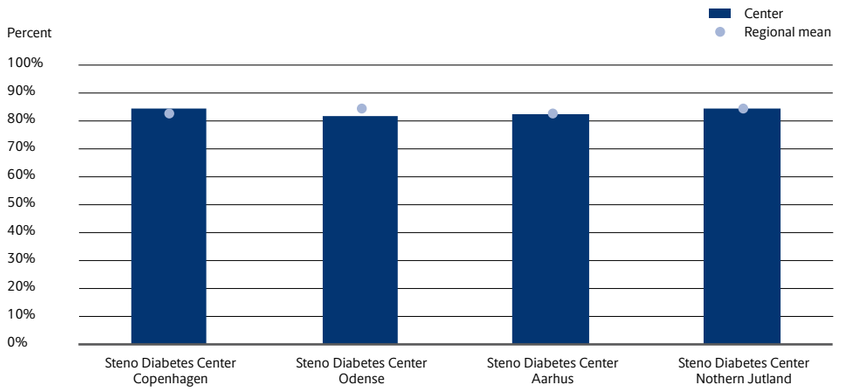
Healthy lipid level (percent with LDL cholesterol level <= 2.5 mmol/l) among patients with Type 1 diabetes treated at Steno Centers and in Danish hospitals in general



Sources: Novo Nordisk Foundation and the Clinical Database for Diabetes in The Danish Clinical Quality Programme.

Figure 2.7.6 d Patient care in the Steno Diabetes Centers benchmarked against other Danish hospital wards

Healthy lipid level (percent with LDL cholesterol level <= 2.5 mmol/l) among patients with Type 2 diabetes treated at Steno Centers and in Danish hospitals in general



Sources: Novo Nordisk Foundation and the Clinical Database for Diabetes in The Danish Clinical Quality Programme.

Figure 2.7.6 shows that for the indicator of good glycaemic control in patients with Type 1 diabetes, the Steno Diabetes Center in Odense fare better than the regional average, whereas the remaining Steno Diabetes Centers have about the same share of patients with good glycaemic control than the average in their respective regions.

For patients with Type 2 diabetes, the Steno Diabetes Centers' in Copenhagen, Odense and Northern Jutland fare better than the regional average, while the Steno Diabetes Center Aarhus have the same share of patients with good glycaemic control than the regional average. The share of patients with LDL-cholesterol levels below 2.5 mM is practically identical in the different Steno Centers and the share matches the regional averages closely.

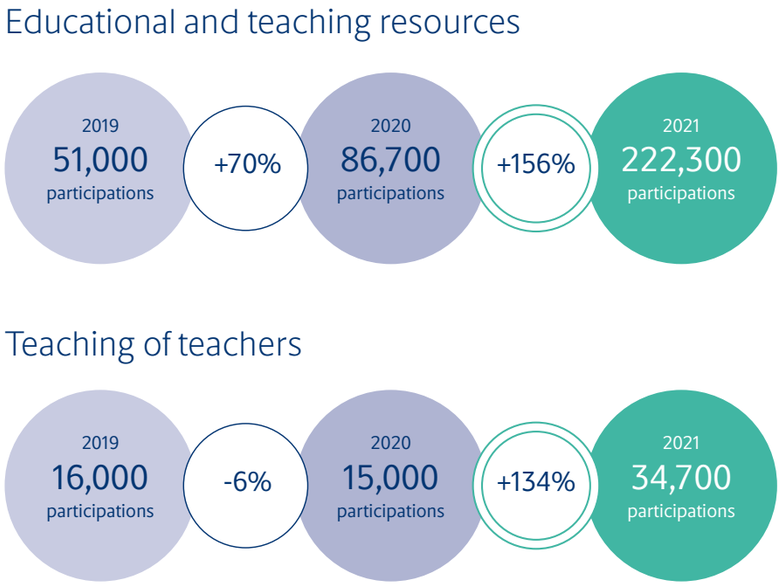
2.8 Supporting the development of world-class education

It is important that every new generation receives the best education possible and that research is used in educations and disseminated across society. This chapter investigates the outcomes of the Foundation's grant-giving within education and outreach activities. We show the number of school initiatives and the reach through our different types of education grants (pre-school to youth education, higher education, and specific research education programmes) and the education activities indirectly funded by research grants. Lastly, we show the results of the Foundation's support for outreach.

School initiatives aimed at STEM education

The Foundation is dedicated to developing world-class education within science and technology to cultivate engagement, learning and the development of competencies within the field for children and adolescents. We support STEM education from early school to youth education. In the period 2018–2021, the Foundation supported 171 education initiatives (total amount DKK 2.53 billion or EUR 340 million). In 2021 there were more than 220,000 participations by children, youths and adults. The education activities vary greatly in kind and reach, and include visits and laboratory experiments at the LIFE campus, online competitions and training of teachers within the STEM fields. The reach by school initiatives has grown since 2019 (Figure 2.8.1), especially through the development of online materials and online courses.

Figure 2.8.1 Number of people reached by school initiatives aimed at STEM education, 2019–2021



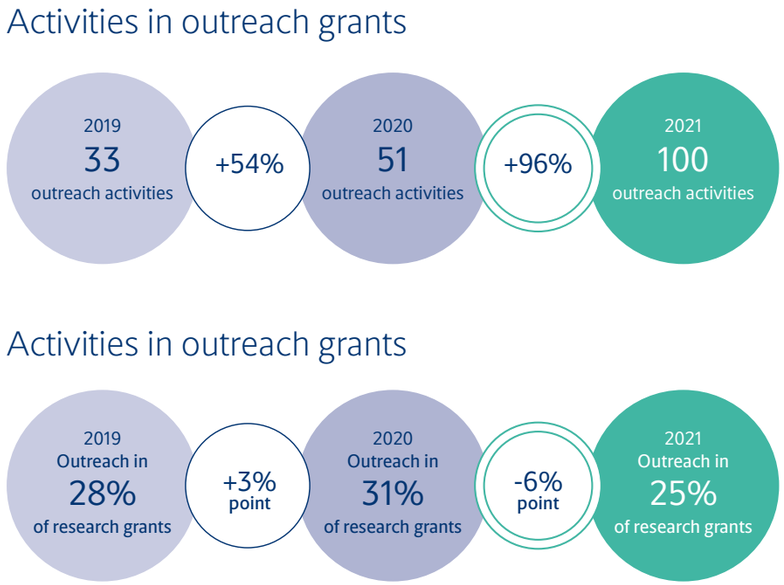
Sources: Novo Nordisk Foundation/Foundgood/Researchfish®.

Outreach activities within natural sciences

The Foundation has open calls that focus specifically on natural science communication using novel communication platforms. The aim is to contribute to engagement and interest in natural science and technology and to facilitate a qualified public debate on topics within natural science. Outreach activities within STEM are also a growing field of funding for the Foundation, and in the period 2018-2021 more than DKK 222 million DKK was awarded to outreach projects.

Activities on science communication and public debate include festivals, science debate (workshops, conferences, online events, podcasts etc.) and talks and presentations to the non-scientific community. Activities that provide science-based experiences outside the formal educational system include development of exhibitions at science museums, learning games and science clubs for children.

Figure 2.8.2 Foundation-funded outreach activities and their reach from pre-school children to adults



Sources: Novo Nordisk Foundation/Foundgood/Researchfish®.

Kometernes Jul
(Christmas of the comets)

Every year, Danish television produces a 24-part television series aimed at children as a Christmas advent calendar. This year, the advent calendar “Kometernes Jul” (Christmas of the comets) was mainly funded by the Novo Nordisk Foundation and the Villum Foundation.

Kometernes Jul had a distinct focus on STEM, with a goal of strengthening an interest in STEM and the scientific aspirations amongst its viewers. Kometernes Jul reached 2,760,000 viewers. Approximately 55% of the children aged 7-14 years old viewed one or more episodes, which equates to 280,000 children.

An independent analysis by VIVE was made to determine whether the TV series had any effects on interests in STEM among children who watched it. The analysis concluded that it is not possible to identify a statistically significant effect on the interests in STEM among the viewers, when compared to a control group of non-viewers. Although there were minor differences between the viewers and the non-viewers, these differences could depend on other factors.

The children aged 7-10 years focused mostly on the entertainment value, while those aged 11-14 years could understand the natural science content of Kometernes Julto a higher degree.

The children who could identify with some of the main persons/characters, who had parents with higher education and/or a priori were interested in natural science were more interested in the natural science content. There are also some minor differences between boys and girls. The boys who have seen Kometernes Jul are to a higher degree interested in the natural science content compared to the girls.

STEM Stands for

Science, Technology, Engineering, and Math.

Figure 2.8.4 a
Effect analysis of Kometernes Jul - Aspiration

Sources: VIVE

Figure 2.8.4 b
Effect analysis of Kometernes Jul - Motivation

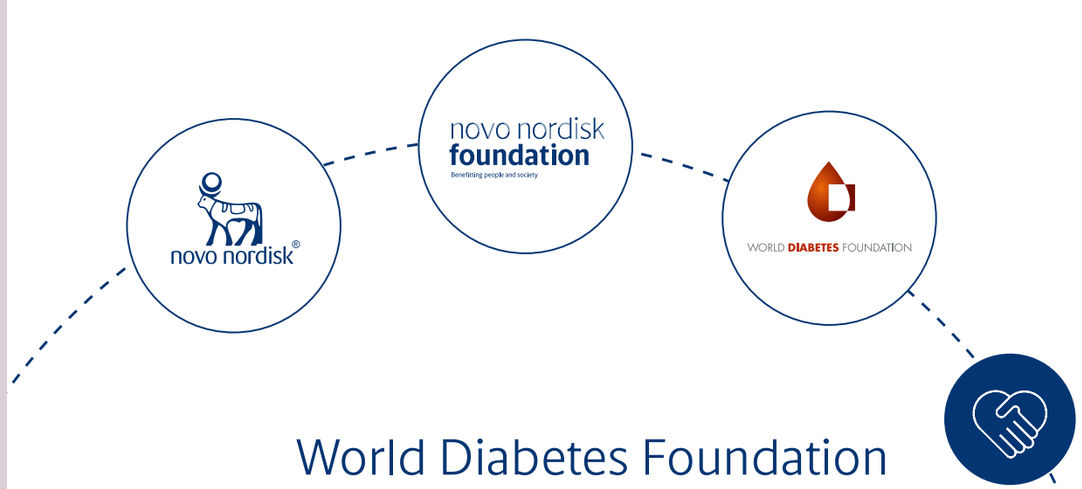
Sources: VIVE

Foto: Key Visual TV 2, Chr. Geisnæs

2.9 Supporting people in difficult settings

Supporting people in low- and middle-income countries
The Foundation's aid initiatives in low- and middle-income countries (LMICs) have aimed to improve the opportunities of vulnerable people affected by humanitarian crises and poverty with a strategic focus on youth empowerment and fighting non-communicable diseases (NCDs). Through a wide range of partners such as the World Diabetes Foundation (WDF), the Red Cross, UNICEF, PlanBørnefonden and the Danish Refugee Council, the Foundation has awarded more than DKK 620 million (EUR 83 million) for projects in Jordan, Lebanon and several countries in Eastern Africa.

With the current strategy, the strategic programmes in LMICs will focus on fighting inequity in health. The ambition is to improve the health outcomes for patients living with diabetes and other cardiometabolic diseases by improving local capacities for NCD prevention and care. Diabetes and other NCDs are among the greatest health challenges of the 21st century, not least in LMICs, where NCDs add to the existing burden from communicable diseases, creating a double disease burden which their health systems are unable to cope with. This next section will focus on the learnings from WDF partnership programmes that were granted under the previous strategy in this field.



World Diabetes Foundation

WDF is an independent non-profit foundation founded by Novo Nordisk A/S in 2002, with a vision to alleviate suffering related to diabetes and its complications among those in greatest need.

Through a wide network of local and global partners, WDF promotes access to diabetes prevention and care for underserved populations in LMICs.

The World Diabetes Foundation – Novo Nordisk Foundation partnership on NCDs
WDF has been a strategic partner to the Foundation in fighting NCDs since 2018, when the first multi-year grant was awarded for a comprehensive NCD intervention in Tanzania. Since then, the Foundation has awarded six strategic grants to WDF at a total value of DKK 235 million (DKK 180 million have not yet been paid out), with the purpose of scaling up NCD prevention and care in Jordan, Lebanon and East Africa, thus innovating and integrating NCD care in the humanitarian response. In addition, four smaller humanitarian grants with a total value of DKK 18 million have been awarded WDF in connection with the COVID-19 response, to mitigate the disruption of essential NCD services due to the pandemic.

The Foundation support has allowed WDF to scale interventions, thereby enhancing the capacity of local partners and health systems to prevent and manage NCDs and improving access to care for vulnerable people including refugees and underserved communities.

World Diabetes Foundation - Foundation Partnership

results since 2019 on access to NCD prevention and care

- 725 primary healthcare clinics strengthened to provide NCD care
- 2,617 health care professionals trained
- 2,422 type 1 diabetes patients enrolled in care programmes
- 110 schools engaged in healthy schools programmes, reaching approximately 19,000 students
- Health promotion activities for the larger public in three countries
- 40,000 patients recruited for clinic-based counselling and prevention
- Formative and implementation research in four programmes
- Strategic partnerships established with WHO, UNHCR, ministries of health to create policy change for improved NCD care

Source: World Diabetes Foundation and Novo Nordisk Foundation.

The Novo Nordisk Foundation

World DiabetesFoundation partnership on NCD prevention and control in Jordan

Since the beginning of the Syrian crisis in 2011, Jordan has been hosting the second highest number of Syrian refuges globally, many of whom have poor access to health-care. In response to the crisis, the Foundation initiated a partnership project with WDF in collaboration with the Jordanian organi-sation the Royal Health Awareness Society in 2020.

The aim is to improve access to NCD services for refuges and vulnerable Jordanians. This is done by integrating prevention and care of NCD (with attention to diabetes and hypertension) into primary healthcare services. In addition, the project has a focus on primary prevention to raise the awareness of communities, children and youths about NCD risk factors and encourage a healthy lifestyle. The project takes an innovative approach including establishment of healthy community clinics at primary healthcare level and support to the new healthy school programmes (see details in box to the right).

With one year left of the project, results and outcomes are starting to emerge: In partnership with the Ministry of Health and international NGOs, the initiative has trained health staff and strengthened NCD care at 97 primary health centres by implementing the healthy community clinic model in remote and underserved areas. This has enabled enrolment of patients with diabetes or hypertension into clinic-based counselling and patient support groups with regular follow-up and referral to prevent complications.

Through scale-up of the healthy school programmes in 110 public schools, 19,000 pupils and their families have been reached with awareness activities on healthy diet, physical activity and tobacco use from teachers and youth volunteers. The awareness raising and competitions have a extended effect on the teachers' and students' families, as children have become ambassadors for a healthy lifestyle within their homes and communities.

In partnership with the Ministry of Youth, 200 youths have been recruited as volunteers and advocates promoting health messages in their networks through various channels such as community-based organisations, schools and youth centers. The youths report how the volunteering opportunities make them feel like role models to children and other young people and how this has also reflected positively on their own commitment to a healthy lifestyle.

Finally, the project has established partnerships with public and private sector stakeholders as well as NGOs to reach refugee populations. Advocacy efforts and the capacity building for inclusion of NCDs within the core health and refugee services and, in sector strate-gies have paved the way for new coopera-tions and funding opportunities which will enhance the sustainability of the project.

Two main components

Healthy community clinic and a healthy schools programme

Healthy Community Clinic

The Healthy Community Clinic is a tested model to integrate prevention services at the primary healthcare level, where NCD patients are already going for medical check-ups or treatment, making the centre a one-stop shop with improved quality of NCD care. The health community clinic-seeks to build the capacity of the healthcare providers, improve access to screening, awareness, counselling, monitoring and referral services, while also enabling the patientsto better control their disease through lifestyle modifications and tackling risk factors.

Healthy Schools programme

The Healthy Schools programme aims to cultivate a healthy and safe environment within schools through enhanced provi-sion of health-related services and health education to all students. The programme encourages a high level of involvement of the local community through the various health activities and awareness sessions and youth volunteers. It encourages the young generations to adopt healthy lifestyles, but also to have them become ambassadors of change within their families.

Source: WDF.

Chapter 3

The societal impact of commercial activities

The commercial purpose of the Novo Nordisk Foundation is to provide a stable basis for the commercial and research activities of the life science portfolio of companies, including Novo Nordisk A/S and Novozymes A/S, which the Foundation controls through Novo Holdings A/S or has a substantial investment in (stakeholder share).

This chapter details some of the societal impacts of these commercial activities. The impacts vary greatly, both because of the different nature of the activities and because the data related to these are very different.

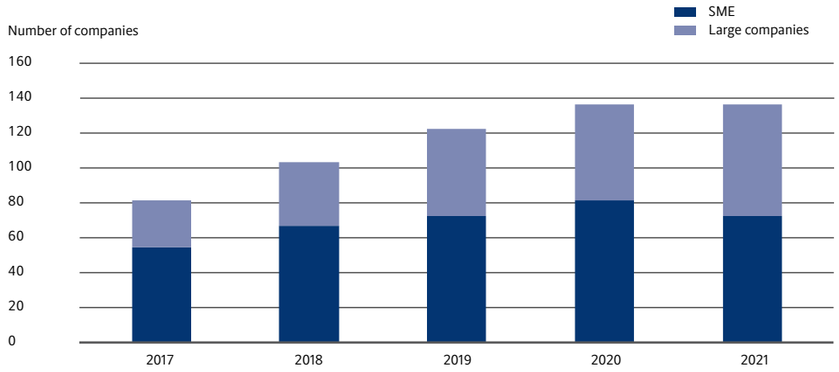
The societal impact of the commercial activities is also different from the impact of the philanthropic activities as the companies controlled and invested in are already established with pipelines of products, services and clinical trials, and in some cases mature multinational companies with high turn-over and many users of products and services.

This chapter focuses on the Novo Group and equity investments life science companies where Novo Holdings' ownership share exceeds 5%. Unless stated otherwise, the analyses include Novo Nordisk A/S, Novozymes A/S and Novo Holdings A/S.

3.1 Fostering the development of talent

The size of Novo Holdings' company portfolio has grown since 2017, both in terms of the number of companies, and employment. Since 2017, the number of companies in the portfolio has increased by 67%. It has grown from 82 companies to 137 in 2021, including Novo Nordisk A/S and Novozymes A/S (Figure 3.1.1).

Figure 3.1.1 The number of life science portfolio companies, 2017–2021



Note: The portfolio is here defined as companies with equity investments in life science companies and includes Novo Nordisk A/S, Novozymes A/S and Novo Holdings A/S.
Sources: Novo Nordisk Foundation and Novo Holdings.

A large proportion of companies in the life sciences portfolio fall within the small and medium sized category, including investments in start-up companies with future potential for growth. The size of the SME portfolio has grown from 55 in 2017 to 73 SMEs in 2021 (Figure 3.1.1).

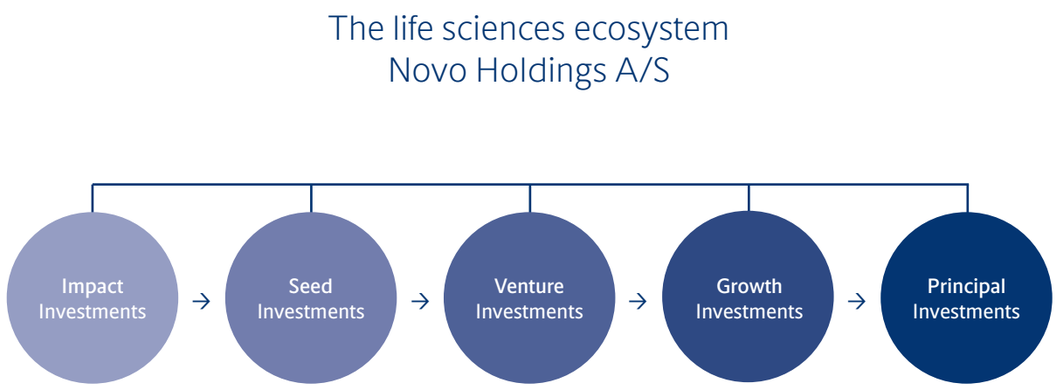
The company portfolio consists of very research-intensive companies, which is reflected in the research talent employed in these. In 2021, the life sciences companies employed more than 1,250 PhDs and 185 MDs, excluding the Novo Nordisk A/S and Novozymes A/S. Novo Nordisk A/S and Novozymes A/S have a high R&D ratio, and approximately 10% of the employees are working with research and development.

3.2 Supporting organisations, systems, and infrastructure

One of the Foundation's missions is to invest in scientific research, education and innovation to enable a world-class life science ecosystem. It has been a part of the heritage of the Novo Nordisk Foundation for almost a century to support fundamental research and the development of novel technologies that have the potential to benefit people and society. Building on this legacy, the Foundation aims to increase its commercial support for building an ecosystem that is needed for excelling within the life science and sustainability areas, and to help solve some of the major challenges facing us in the future.

We have the ambition to support the life science ecosystem as a dynamic entity. Figure 3.2.1. shows how Novo Holdings' corporate activities support the life science ecosystem across the entire corporate value chain, from seed investments to investing in large companies within the ecosystem.

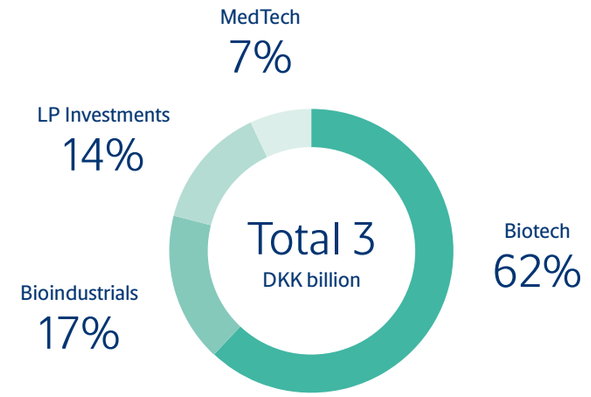
Figure 3.2.1 The life science ecosystem of Novo Holdings



Sources: Novo Nordisk Foundation.

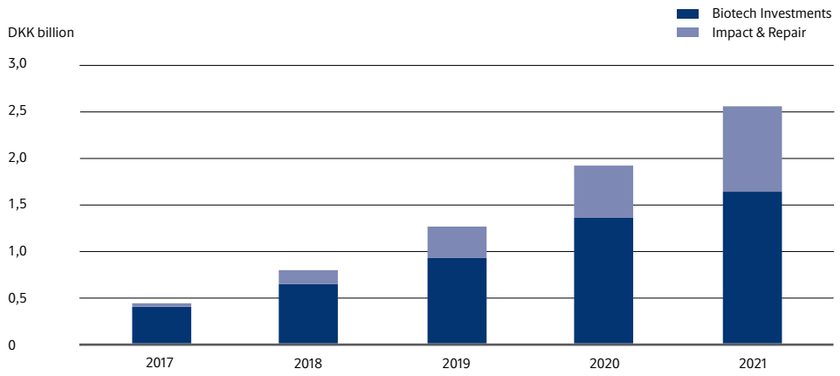
To promote the transition between spinouts and commercial investments, Novo Holdings has established the investment team Novo Seed, including the REPAIR Impact Fund. The allocation of funds to this part of the life science ecosystem is shown in Figure 3.2.2. The value of the Novo Seeds investment portfolio was more than six times higher in 2021 than in 2017.

Figure 3.2.2a The Novo Seeds investment portfolio by sub-sectors, end of 2021



Source: Novo Holdings A/S.

Figure 3.2.2b The allocation of funds for start-up companies and impact investments in life science



Source: Novo Holdings A/S.

3.3 Stimulating collaboration

Through its holdings company Novo Holdings A/S, the Foundation owns and invests in research-intensive companies that publish journal articles. This section analyses the university-industry co-authorship patterns of these articles.

The companies in the portfolio published more than 3,341 journal articles from 2017 to 2021. 88% were published with co-authors from academia. The share of international co-authorships is high, with the proportion of international co-authorships increasing from 69% in 2016–2020 to 71% in 2017–2021.

Researchers at University of Copenhagen have published 620 journal articles with the portfolio companies since 2017. The second highest number of articles by portfolio companies co-authored with academia is with the Technical University of Denmark (252 articles). The portfolio companies publish with all top 25 highest ranked universities (measured by share of publications among the top 10% most cited in the field) in the world within biomedicine and health sciences. Table 3.3.1 shows the five universities with the highest number of articles co-authored with portfolio companies.

Table 3.3.1 The five universities with the highest number of articles published with portfolio companies

Institution	Number of journal articles co-authored	Leiden Ranking
University of Copenhagen	620	164
Technical University of Denmark	252	158
Medizinische Universität Graz	227	312
Universität Heidelberg	195	205
University of Oxford	154	7

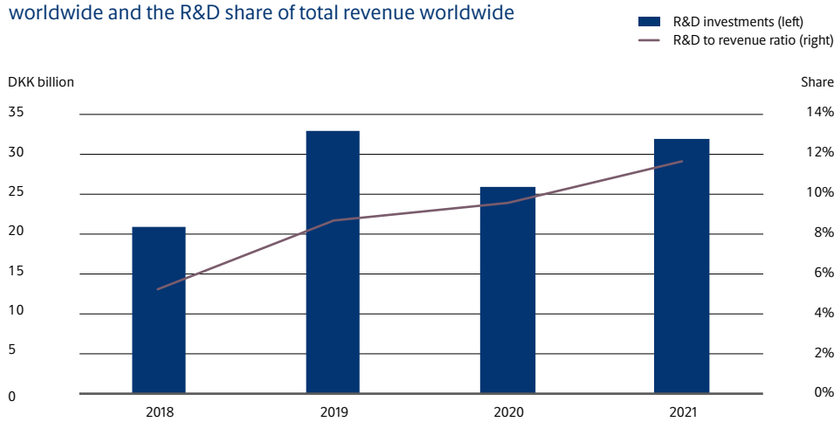
Sources: Novo Nordisk Foundation/Impact-of-Science, Scopus and Leiden Ranking 2021.

3.4 Promoting excellent research and innovation

Research and development ratio (R&D-ratio)

Many of the portfolio companies are research-active and spend a high share of their revenue in private research and development investments. Figure 3.4.1 shows the development in the R&D ratio of the companies in the portfolio. The ratio is stable and growing.

Figure 3.4.1 The Novo Nordisk Foundation Group's investment in private R&D worldwide and the R&D share of total revenue worldwide

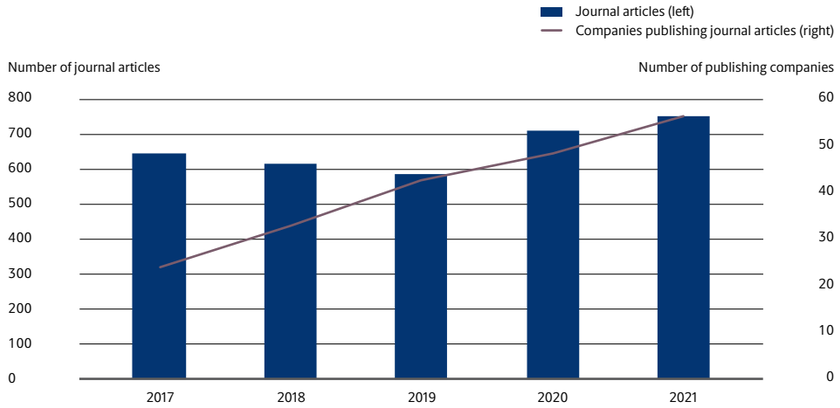


Sources: Novo Nordisk Foundation and Novo Holdings.

Scientific journal articles from Novo Nordisk A/S, Novozymes A/S and the life science portfolio companies

The R&D investments result in a high output of new knowledge and ideas. The companies published 3,341 journal articles in the period 2017–2021. In 2021 alone, 758 journal articles were published by 57 different companies in the portfolio (Figure 3.4.2). Over half of the companies published a journal article in 2021.

Figure 3.4.2 Research active companies and journal articles, 2017–2021



Sources: Novo Nordisk Foundation, Novo Holdings and Scopus.

Citation impact of journal articles from the life sciences companies including Novo Nordisk A/S and Novozymes A/S

Journal articles published by the companies invested in have an impact well above the world average. Specifically, in 2020 the impact was higher than the world average, with 5% of the journal articles being ranked among the top 1% most cited and 20% among the top 10% most cited in the world. These levels are similar to the levels for articles published by Foundation-funded researchers – suggesting the applied nature of the research does not decrease its citation impact.

Science fields of journal articles from the life sciences companies including Novo Nordisk A/S and Novozymes A/S

Most articles (475 journal articles) were published by portfolio companies within endocrinology, diabetes and metabolism in the period 2017–2021, with 21% of articles among the world's 10% most cited within this field. The second highest output are within internal medicine, with 341 journal articles of which 22% is among the world's 10% most cited. The third most frequent field of science being covered in 265 journal articles by portfolio companies is endocrinology with 26% among the world's 10% most cited. More than 200 journal articles are published within biochemistry. The 130 journal articles published by the companies within cell biology have the highest share of articles (29%) among the world's 10% most cited articles within these fields.

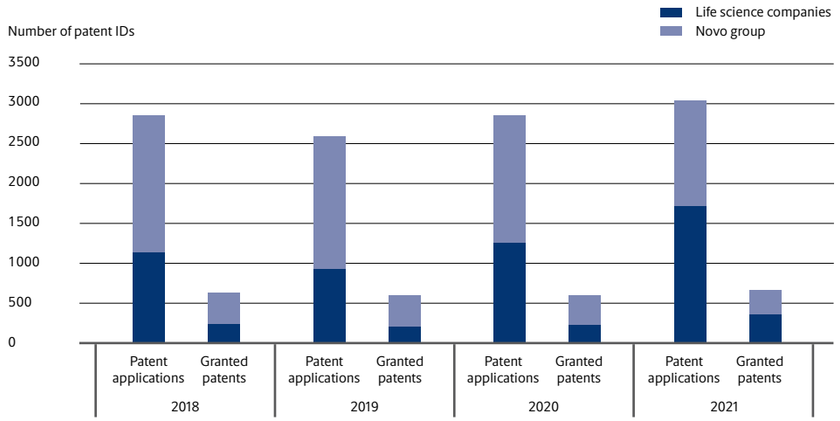
3.5 Developing innovative products and solutions

This section examines how the life science portfolio companies are contributing to development of new solutions as revealed by their product and patent activity. 74 new products were launched in 2021, of which seven were new drugs, 37 were new MedTech products and 30 were bio-industrial products.

The portfolio companies have contributed to numerous patent applications. Since 2018, more than 13,800 patent applications have been published by the portfolio of companies, and more than 2,500 patents have been granted (Figure 3.5.1). Multiple patent documents can be published for each technological innovation, as they can be patented in multiple jurisdictions. 5,227 technological innovations are represented in the published patent applications, and 1,953 technological innovations are represented in the granted patents.

The number of published patent applications and granted patents in a particular year reflects the number of patents filed some years previously, as patents are not published until 18 months after filing and are granted around three and a half years later. It should also be noted that many patent applications are dropped before a patent decision is reached. In 2018–2021, portfolio companies accounted for 20% of all granted patents and 20% of all published patents in Denmark.

Figure 3.5.1 Number of patent applications and granted patents filed in the Novo Group and the life science portfolio companies across technologies, 2018–2021



Sources: Novo Nordisk Foundation/Impact-of-Science, Novo Holdings, Dimensions.

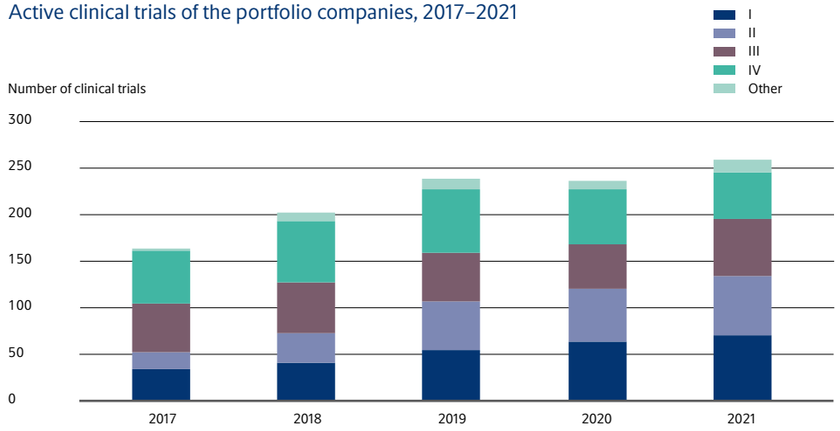
3.6 Developing new technologies, therapies and disease prevention

A large proportion of the patents and products, both launched and in the pipeline of portfolio companies, are new medicines and healthcare products. These are examined further in this section.

Clinical trials in companies

Before new medicines and therapeutics can be launched, they undergo vigorous testing in clinical trials. Between 2017 and 2021, 471 clinical trials were registered by portfolio companies in global clinical trial registries, making up 0.5% of all clinical trials registered during the same period (Figure 3.6.1). The clinical trials of companies tend to be associated with more advanced trials stages (phases III and IV) compared to clinical trials of public researchers. 97% are in official clinical trial phases I-IV, with 50% being in early clinical trial phases I and II, and 47% in late clinical trial phases III and IV.

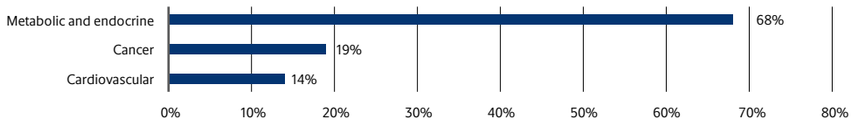
Figure 3.6.1 Active clinical trials of the portfolio companies, 2017–2021



Note: Active clinical trials of a given year. A clinical trial longer than a year will therefore appear in multiple years.
Sources: Novo Nordisk Foundation, Novo Holdings, and PharmaIntelligence.

Further analyses of the clinical trials show which health areas the clinical trials fall within. Most trials are in metabolic and endocrine conditions, which include diabetes (Figure 3.6.2).

Figure 3.6.2 Top three health categories of clinical trials, 2017–2021



Sources: Novo Nordisk Foundation, Novo Holdings, PharmaIntelligence, and clinicaltrials.gov.

To ensure that new medicines and therapeutics are both safe and effective, they must be tested on several people. Over the past five years, more than 167,000 people have been successfully enrolled in clinical trials supported by the portfolio companies.

Globally, ensuring diversity among the participants in clinical trials has been, and continues to be, an issue both in terms of biological sex and ethnic groups. If trial participants do not accurately reflect the patient population the drug aims to treat, it may not be safe to extrapolate the results of the trial to predict the benefits or adverse effects when treating the population. It was possible to find biological sex data in 17% of the clinical trials supported by portfolio companies on clinicaltrials.gov and for 37% of all people enrolled in the clinical trials. Among the clinical trials that do report on biological sex, there was an equal distribution with 48% female and 52% male participants, excluding clinical trials dealing with sex-specific illnesses such as prostate cancer.

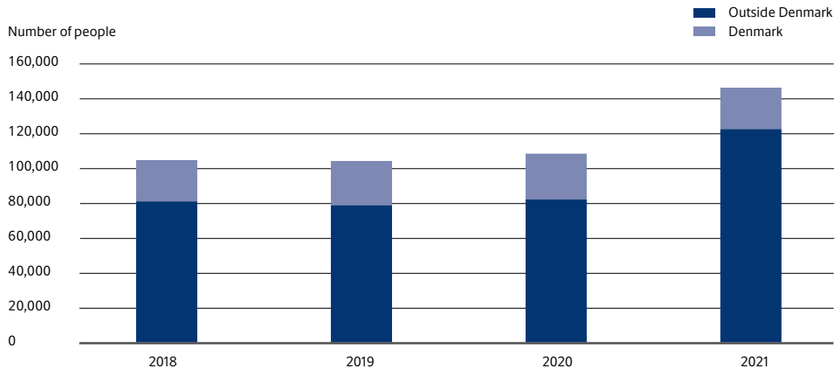
Developing treatments for rare diseases has historically been under-prioritised, as the limited number of patients reduces the economic incentive. 'Orphan drug' status is one approach to addressing this, by providing incentives to companies to develop such drugs. The status is awarded to drugs aimed at rare diseases that are life-threatening or chronically debilitating, but where there is not currently any effective treatment. Thus, the orphan drug status can be used as an indicator of drugs with immense potential impact for patients living with these rare diseases.

Among the drugs in the commercially supported clinical trials, 38 of the trials have at least one orphan drug designation, with a total of 116 individual orphan drug designations. These designations include therapies for amyotrophic lateral sclerosis (ALS) and glioblastoma (an aggressive form of brain cancer). A parallel designation system is the FDA fast track designation, which aims to speed up clinical trial processes for drugs addressing an 'unmet clinical need'. 11 of the drugs also have a fast-track designation indicating they have big potential to improve patients' lives.

3.7 Creating jobs and growth

In 2021, the Novo Group and the life science companies employed about 145,000 people, which is 37,800 more than the year before (Figure 3.7.1). Of these, almost 18% are employed in Denmark.

Figure 3.7.1 Number of people employed in Danish based and foreign based companies, 2018–2021



Sources: Novo Nordisk Foundation/Impact-of-Science, Novo Holdings and Statistics Denmark.

3.8 Supporting people in difficult settings

The products and services of the companies in the Novo Nordisk Foundation Group help millions of people every year with pharmaceutical products, medical devices and technologies, and health services, including clinical health tests.

People reached with pharmaceutical products (medicine)

The Foundation is built on the success of Novo Nordisk A/S alongside other pharmaceutical companies. Today, through Novo Holdings, many investments have been made in companies that develop and supply vital medicines for people all over the world. In 2021 alone, it is estimated that the portfolio of companies provided medicines to more than 40 million patients (Figure 3.8.1).

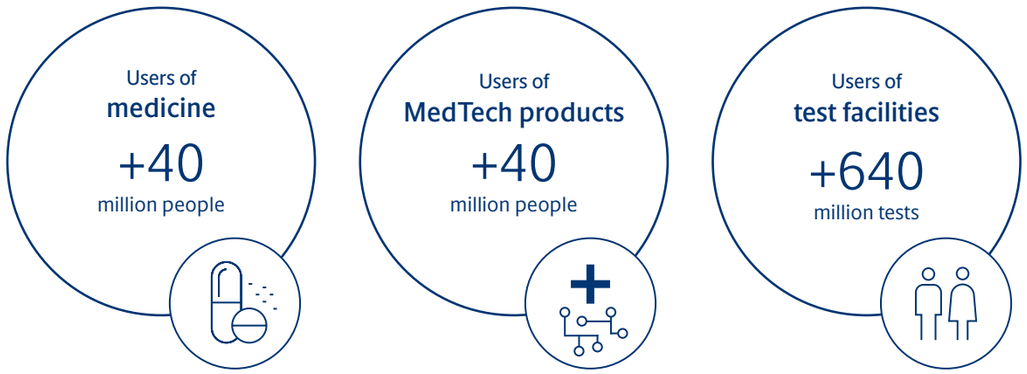
People reached with technology products (MedTech)

The Novo Nordisk Foundation Group owns medicine device and technology companies which deliver solutions to millions of people in all age groups within hearing health, chronic diseases and other types of healthcare and patient care. An example is Novo Holdings' 100% ownership of Sonion (since July 2014), a global leader in designing and manufacturing components and solutions for hearing instruments (hearing aids, in-ear earphones, and hearables/wearables) to improve people's quality of life all over the world. From small children to elderly people who have spent decades in silence, Sonion helps over 40 million every year.

People reached with test facilities and services

The life science portfolio also comprises health test and diagnostics facilities. Laboratory medicine makes a significant contribution to medical care. Around two thirds of medical diagnoses worldwide are based on or confirmed by medical laboratory tests. In February 2017, Novo Holdings invested in SYNLAB, which provides modern laboratory analyses that help to confirm diagnoses, derive the right decision from them and monitor the success of therapy. SYNLAB conducted more than 640 million tests in 2021 compared to estimated 500 million in 2020.

Figure 3.8.1 People reached, 2021



Sources: Novo Nordisk Foundation, Novo Holdings, Novo Nordisk A/S, Sonion, Synlab.

Chapter 4

Learning from philanthropic practise

This chapter provides a quantitative comparison of input, outputs and outcomes for selected research funding instruments. Funders face many decisions when developing and implementing funding strategies to deliver their objectives. Deciding when to use a particular funding instrument has often been a matter of judgement, intuition and frequent debate.

This analysis provides the first step towards substantiating qualitative judgements with data to support the learnings from our philanthropic practice.

4.1 The Novo Nordisk Foundation's grant-giving models and instruments

Guided by its strategy and nine societal impact principles, the Novo Nordisk Foundation currently distributes its grants through five streams coined by the Foundation as its grant-giving models:

The Novo Nordisk Foundation's five grant-giving models (philanthropic models)

1 Open competition grants
These are advertised to the academic community, and applicants are encouraged to put forward their best ideas for funding and compete for a limited amount of grants. Many different instruments are employed here, most commonly shorter-duration project grants focused on the proposed project itself, and longer-duration investigator grants at different career stages focused on both the project and the applicant.

2 Stand-alone grants
These are awarded on peer-review basis outside open competition, but may use any available instrument, including but not limited to, project grants, investigator grants or fellowships, infrastructure grants, collaborative research programmes, educational platforms, or research centres.

3 Partnership grants
These are used for engaged collaborations with public partners (public-private partnerships) and/or private partners (private-private partnerships).

4 Impact investment
These are directed towards companies, e.g. start-ups, often in the form of loans and investments in equity (private or public) or impact bonds (pay-for-performance investments) where the purpose is to support activities from a positive societal impact perspective. Targeted at early-stage development of therapies targeting resistant microorganisms, the Repair Impact Fund is an example of an impact investment initiative.

5 Own initiatives for later spin-out
These start as local units in the Foundation but are then spun out, e.g. as independent foundations, after approval by the Board. Examples include the BioInnovation Institute Foundation and the LIFE Foundation.

The analysis presented here covers four of the Foundation's open competition instruments (project grants, emerging/ascending investigator grants, innovation grants, and challenge grants), and four large grants for research centres provided through the stand-alone grant-giving model.

Different grant-giving models have different approaches to interaction with applicants. Grants in open competition are used widely to reach many grantees in an efficient way by offering standardised application procedures, bottom-up competition for funding, and arm's length peer-review based selection and allocation of funding.

Stand-alone grants and partnership models do not make use of competition through open calls. While they make use of external expert peer-reviewers, approval or dismissal is made solely and directly by the Foundation's Board of Directors.

The two models differ in how the Foundation engages with the applicant(s) or external partner(s). In the stand-alone grants approach, the Foundation may receive an unsolicited application from the applicant, or it may ask an institution to develop an application for an initiative with a specific scope predefined by the Foundation. The Foundation's new CO2 research centre at Aarhus University is an example of this. In all cases, the responsibility for the final application lies with the applicant while receiving iterative feedback from the Foundation. In the partnership model, the application is driven by the Foundation's project team and co-developed between the external partners and the Foundation, but potentially also with key stakeholders. A prime example of a large partnership is the Steno Diabetes Centres developed in collaboration with each of the regions in Denmark.

In the period 2016-2021 the Foundation awarded grants for at total amount of DKK 33 billion (EUR 3.4 billion). The distribution of awarded amount on the five grant-giving models is the following: One third went to open competition, 30% to stand-alone initiatives including research centres and research facilities, 27% to partnerships, 7% to own initiatives and 3% to impact investments.

Within each model, several different instruments are used. This study focuses on the level of funding instruments by examining project grants, innovation grants, investigator grants, challenge grants awarded in open competition, and the first four Novo Nordisk Foundation research centres awarded as stand-alone grants. The different characteristics of these grants are shown in table 4.1.

Table 4.1 Awarding process for different funding instruments

Instrument	Awarding process	Intent	Anticipated strengths and weaknesses
Project grants	Open competition	Fund the best research ideas with short duration grants effectively.	• Allows exploration of many ideas at small scale. • Difficult to monitor individual projects, exclusivity is low. • Reported results may be clouded by other activities and narrowly focused.
Innovation grants	Open competition	Translation of early research results with innovation potential.	• Emphasis on translatability of findings rather than scientific excellence.
Investigator grants for emerging and ascending investigators	Open competition	Support the career development of researchers.	• Provides young and mid-career researchers with stability to develop their careers. • Success relies not only on individual excellence but also on leadership abilities of the PI.
Challenge grants	Open competition	Address a key challenge identified by the Foundation.	• Provides the scale and time to focus on addressing a valuable question. Awarding a lesser number of larger grants make selection of individual proposals for funding even more important.
Novo Nordisk Foundation Research Centres (Large scale stand-alone research grants)	Applicant drives development of the initiative with feedback from the Foundation	Large scale centres of excellence focused on a particular area that raises the bar of research in international comparison.	• Full scale centres with more than 100 researchers or specialists employed in the centre's teams/labs led by field experts working in a physical centre with access to their own research infrastructure. • Less prone to random ideas from different environments.

4.2 Outputs and outcomes of selected grant-giving instruments

Currently the analysis only attempts to provide quantitative data on some of the outputs and outcomes of the Foundation's grant-giving activities by comparing self-reported outputs and outcomes. In terms of the large-scale stand-alone grants, this analysis examines the Foundation's first four research centres (Centre for Biosustainability, Centre for Protein Research, Centre for Basic Metabolic Research, and Danish Centre for Stem Cell Research). To allow comparison of instruments of very different sizes, the activities, outputs and outcomes are normalised and shown in terms of results per DKK 100 million (EUR 13 million) in funding.

Total funding used to normalise the reported results of each instrument includes

- Granted amount from the Foundation.
- Reported supplementary granted amounts from other sources.
- Reported value of collaborative support (direct funding or estimated in-kind value).

The outputs and outcomes covered in this study fall into three categories

- Publication-based metrics including journal articles and citation impact.
- Research products covering databases and research models, products and interventions, and technical products (often software); and commercial results covering IP and licensing, and spinouts.
- Career development covering team members at different career stages.

Self-reported data and measurement

The grants within the different instruments are expected to perform better or worse in different categories of output and outcome depending on the purpose of the funding instrument. All interpretation rests on the quality of the self-reported data.

Four factors influence the quality of the reported data

1 Accuracy

The reported results are expected to be more accurate and complete for research centres and challenge grants. These grants have annual dialogue meetings with representatives from the Foundation, where a monitoring report based on Researchfish® data is included in the meeting material. The reported results from investigator grants, innovation grants, and project grants are used as-is.

2 Exclusivity

Focused and relatively larger grants such as investigator grants and challenge grants are expected to report less compared to smaller project grants that may be filtered into prior funding and research results, which may exacerbate reported results.

3 Coverage

Since introducing Researchfish® as the chosen research-reporting tool in 2015, more and more grants have reported in the system, but the number of concluded grants with complete reporting is still very limited. Furthermore, the four research centres commenced before 2015. This had led to the following sample setup:

a. Projects grants in 2015–2018 are observed for a period of minimum four years, which covers the grant period and at least one year beyond.

b. Innovation grants in 2015–2019 are observed for a period of minimum two years, which covers the grant period and often one additional year as a minimum.

c. Investigator grants in 2015–2018 cover at least 4 out of 5-6 years of funding. If the observation window covers less than the grant period, the results are normalised accordingly to mitigate underestimation.

d. Challenge grants in 2015–2017 cover at least 5 out of 7 years of funding. As with investigator grants, total funding is adjusted to mitigate underestimation from normalisation.

e. The four research centres all commenced before the introduction of Researchfish® in the Foundation. Therefore, the investments in setting up the centres cannot be judged from this analysis. Accurate expenditure data are used to scale reported results throughout 2015–2021, portraying the cost of running a fully functioning centre but neglecting the costs setting up the centre.

4 Finance

A principal investigator (PI) receiving a grant personally is mostly, but not always, required to have his/her salary covered elsewhere. This is not the case for research centres, where all staff is funded by the centre grant. We refrain from estimating the PI's salary in total funding, which can play a potentially large role for the results in project grants and investigator grants if the PI's time commitment is large.

Table 4.2 provides summary statistics of the instruments and the underlying grants covered. (See next page).

Table 4.2 Summary statistics for the instruments included in the analysis

Instrument coverage	**# grants**	**Total funding*** (DKK m)	**Length** (avg.)	**Years** (grant start)
Project grants	433	1,989.2	2.6 years	2015–2018
Innovation grants	128	391.4	1.2 years	2015–2019
Investigator grants	19	444.0	5 years	2015–2018
Challenge grants	17	1,648.0	7 years	2015–2017
Novo Nordisk Foundation Research Centres	4	5,567 (expenditure in 2015–2021)	7 observed years in Researchfish®	2007–2012, i.e. before Researchfish® in the Foundation

Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science, expenditure data from university administrative records.
Note: *Includes the Foundation's core funding, further funding, and collaborative support, but not the financing of the PI.

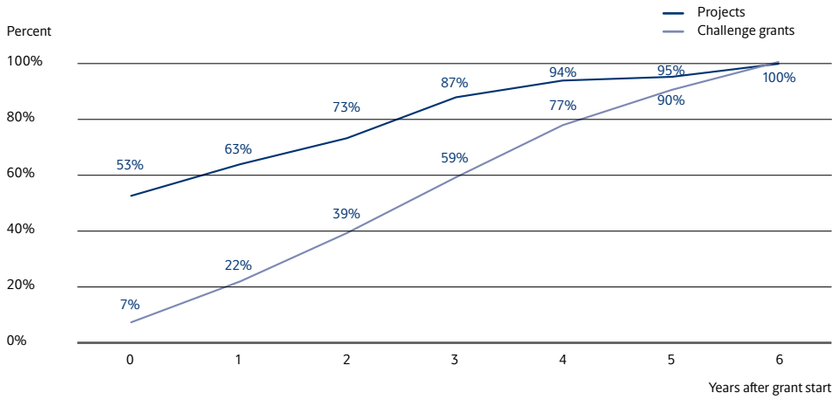
The decision to include grants that are not concluded introduces a level of uncertainty about the results, as the full trajectory of reported results is not yet known.

In Figure 4.1, a comparison of 74 project grants from 2015 with a duration of 2-3 years and four challenge grants from 2015 suggests that the growth in reporting activity is nearly linear throughout the grant period (year 0-2 for project grants; year 0-6 for challenge grants). Within four years, the bulk part of reporting for project grants is observed. Also note that for project grantees, a notable share of their total reporting falls within the first year of reporting. In comparison, challenge grants start out with a lower fraction of cumulated reporting in the first year, bearing in mind that reporting is spread over more years within the grant period.

Considering the complexity and potential of the challenge grants, the ongoing dialogue with the Foundation may hint to an upward bias in reporting from project grants, whereas the full impact of the challenge grants may occur beyond the funding period.

Based on these caveats we include non-concluded grants but normalising the results with an adjusted total funding amount, bearing in mind that challenge grants are likely more understated in this preliminary analysis compared to project grants, and projects grants with their likely higher, assessed, feasibility.

Figure 4.1 Cumulated reporting over seven years for 74 project grants and four challenge grants started in 2015



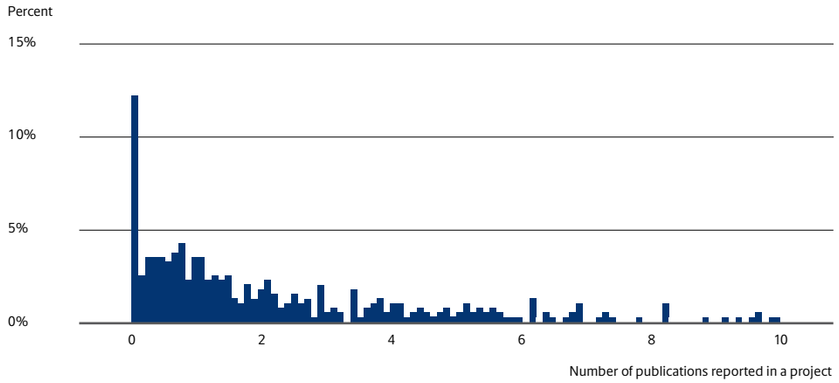
Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science.

4.3 Results of the analysis

The data and results presented here merely constitute a rough assessment of the outputs and outcomes produced. Bearing all the aforementioned caveats in mind, we can make three key observations from the results that follow the predictions made. The first observation relates to the distribution of outputs and outcomes, the second to different grants producing different balances of type of reported results, and the third to the quantity and quality of the reported science.

Distribution of outputs and outcomes
It is striking how skewed the distribution of reported results is across project grants Figure 4.2. This may represent differential reporting, both under- and overreporting, but it could also indicate that success in project grants is sporadic: Either the ideas work, in which case they are a great success, or they do not work, in which case little is produced. Possibly linked to the evaluation criteria concerning feasibility, publications are reported for 88% of the grants. Such characteristics would suggest project grants are fulfilling their intended aim of allowing promising and novel ideas to be tested using a relatively small allocation of resources.

Figure 4.2 Distribution of reported publications per project by recipients of project grants



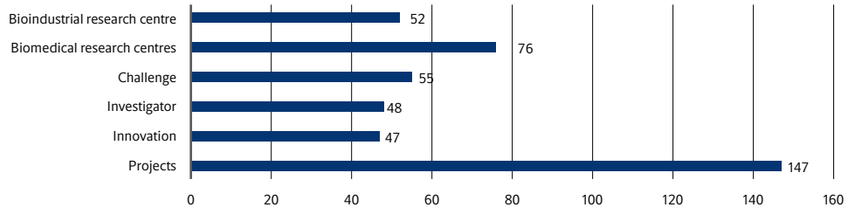
Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science, expenditure data from university administrative records.
Notes: Horizontal axis shows publications reported divided by DKK 1 million in total funding. The tail of extreme values may be caused by extreme reporting in number of publications or underreporting of further funding and collaborative support, or both. Median is 1.34 publications per DKK 1 million in total funding, and 95th percentile is 8.87.

While we include further funding and collaborative support to calculate total funding in order to mitigate an upward bias in productivity (i.e. results per DKK 100 million funded), we are not able to infer anything about past projects and results that may spill over and inflate the results of current projects. The inflation may be less prone in investigator grants and challenge grants, as the amount of funding and the focused attention paid to a research group both from the group itself and the funder(s) may induce more focused and accurate reporting.

Different grants produce different balances of outputs
The trade-off between advancing scientific knowledge and applying that knowledge is often recognised in the design of funding instruments – and the results of this analysis are in line with this view.

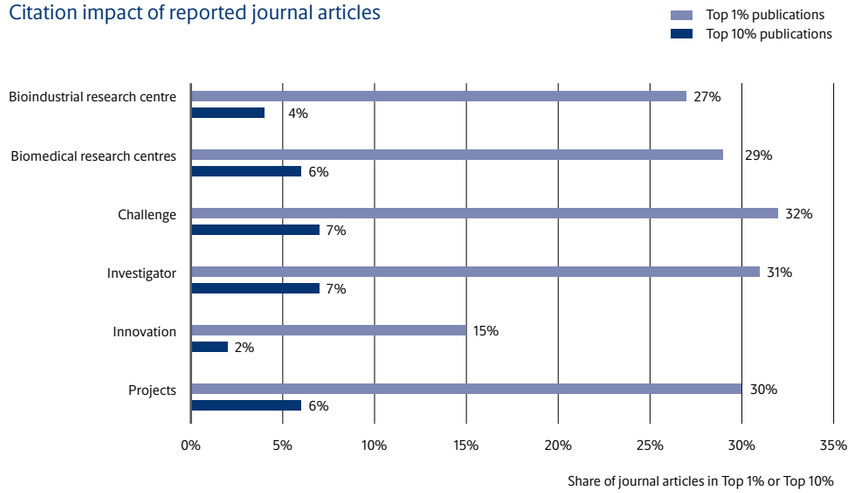
Figures 4.3 and 4.4 focus on scientific publications showing the number of journal articles per DKK 100 million in total funding for each type of grant, and the fraction of those publications that are in the top 10% and top 1% most cited in the world within their fields.

Figure 4.3 Number of journal articles per DKK 100m total funding



Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science, university administrative records.
Note: Number of publications shown are per DKK 100 million total funding (grant, further funding and collaborative support). Total funding does not take into account funding of the PI

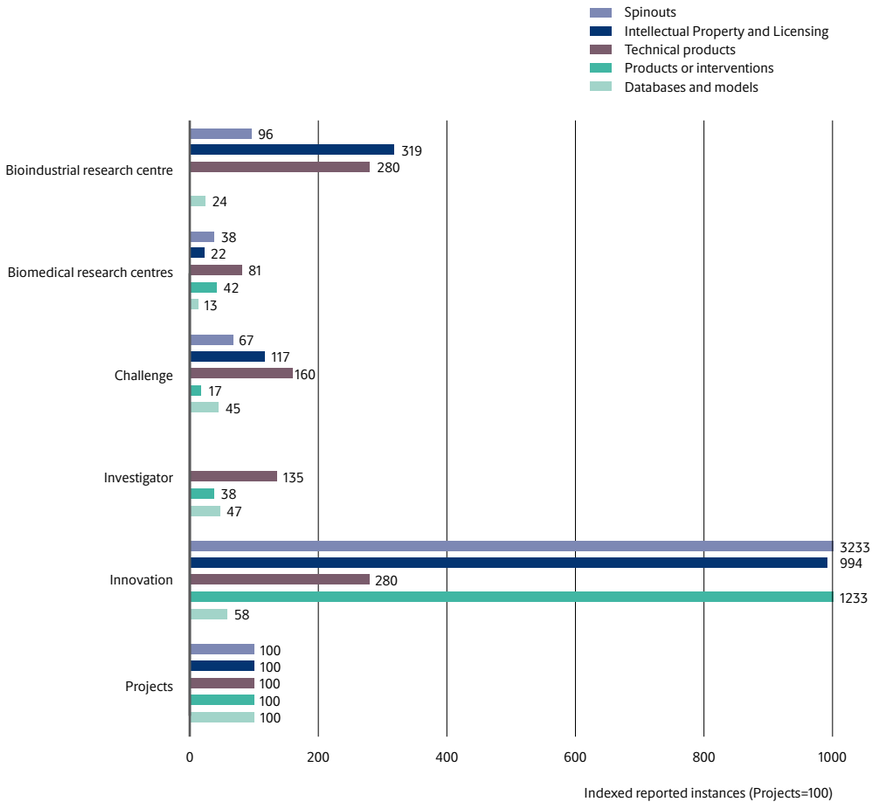
Figure 4.4 Citation impact of reported journal articles



Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science.

In contrast, Figure 4.5 focuses on other research products besides journal articles that indicate technological application such as databases and models, products and interventions, technical products, IP, licensing, and spinouts. In this figure, outputs and outcomes are indexed relative to project grants (index 100).

Figure 4.5 Reported instances of research products and commercial outcomes (IP and spinouts)



Sources: Novo Nordisk Foundation/Researchfish®/Impact-of-Science, university administrative records.

In figures 4.3-4.5, we can clearly see a different balance of outputs and outcomes for academic and commercially focused instruments. The innovation grants report less journal articles cited among the top 10% and top 1% worldwide compared to projects grants of similar size. However, they report massively more application focused outputs and outcomes, so many that the scale in figure 4.5 has to be truncated to show them. A similar story emerges from comparing the Bioindustrial research centre, where research is pivoted more towards applied sciences and innovation, and Biomedical research centres, where – although here the difference is less extreme.

Quantity and quality of science

Considering the research-focused grant instruments, by the publication metrics shown in Figures 4.3 and 4.4, project grants appear to be the most productive instrument by volume of reported publications, followed by the research centres and then challenge grants and investigator grants.

That challenge grants, which are large grants of up to DKK 60 million, follow somewhat behind fully operational research centres and project grants is to be expected: These grants tackle grand challenges and will generally have a longer setup phase in which junior staff must be hired, and co-principal investigators in different locations must establish ways of collaborating across disciplinary boundaries. The level of highly cited journal articles produced by challenge grants shows that they are the best performing funding instrument by this metric – suggesting that the science they produce is of particularly high impact.

It is interesting that biomedical research centres and projects have similar citation profiles and are the grant instruments closest to each other in terms of productivity, especially considering the potential notable upward bias for projects grants from neglected PI salary and the potential reporting of results generated from earlier work – suggesting that although they may address different types of challenges – large scale concentrated effort versus testing promising ideas in established settings – the quality of the science produced is similar and productivity is relatively high for both types.

As shown above in figure 4.2 for project grants, the dispersion in reported results is also wide across the 19 investigator grants included in this analysis. At the lower quartile, investigator grants report the equivalent of 11 reported publications per DKK 100 million in funding, while the median is 57 and the upper quartile shows 88 reported publications per DKK 100 million.

4.4 Discussion

Clearly, these are preliminary results, and more work, time, results, and observations are needed to substantiate the current suggested results. In the meantime, we continue with quality assessments of reported data and submission campaigns directed towards our grantees to highlight the importance of reporting for the Foundation and the Foundation's ability to learn from evaluation of its funding activities. Our experience from delivering feedback to the grantees about their reporting does not simply lead to more reporting, but also more focused reporting, as seen for instance in the removal of reported publications that at closer assessment were not related to the grant in question.

Authors:
Anders Agerbæk Kjøller Nielsen
Clara Siig
Clemens-Hugo Schally
Gert Vilhelm Balling
Henrik Barslund Fosse
Juste Stumbryte
Katrine Iversen
Louise Bresson
Mia Ann Jørgensen
Raquel Roses
Rasmus Vendelbo Lund Jensen
Rikke Nørding Christensen
Thomas Alslev Christensen

Layout : Marianne Siem

Novo Nordisk Foundation
Tuborg Havnevej 19
DK–2900 Hellerup
Denmark

T +45 35276600
E nnfond@novo.dk
W novonordiskfoundation.com

novo nordisk
foundation
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ISBN 978-87-972186-2-4

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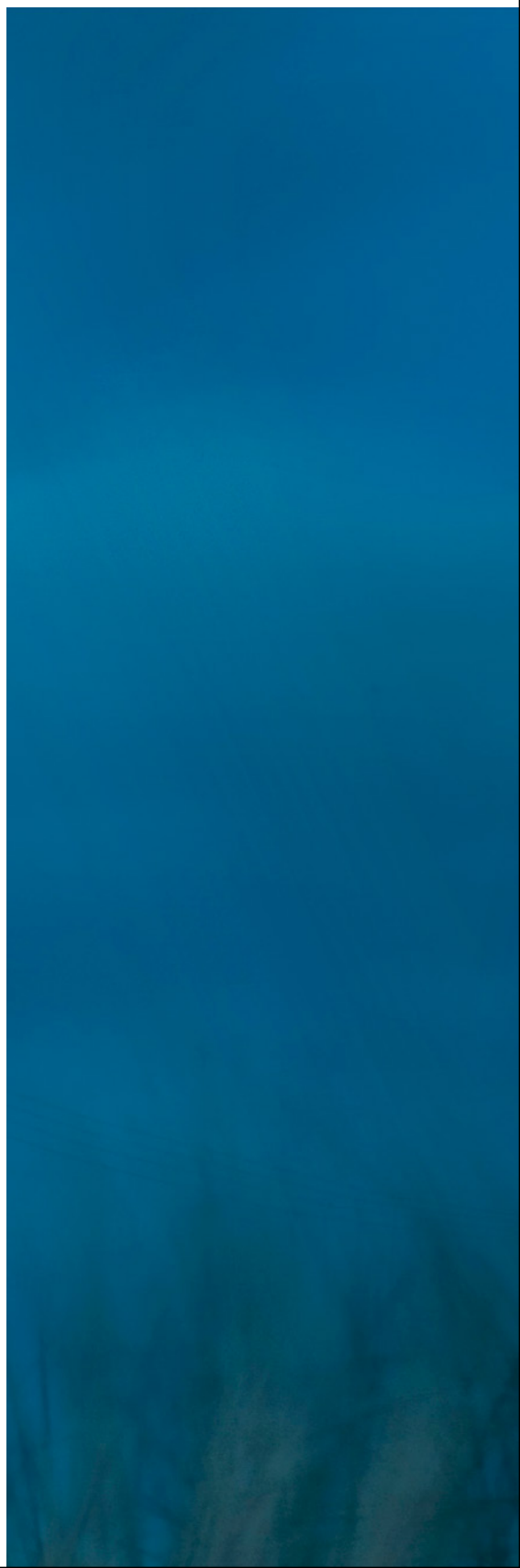

Novo Nordisk Foundation
Tuborg Havnevej 19
DK–2900 Hellerup
Denmark

T +45 3527 6600
E nnfond@novo.dk
W novonordiskfoundation.com