Internship Report

Changing nutrition: assessing the impact of JPI HDHL

July 2023

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Abbreviations

Abbreviation	Definition
JPI HDHL	Joint Programming Initiative ‘A Healthy Diet for a Healthy Life’
IA	Impact assessment
PI	Productive interactions
RRP	Responsible research practices
ZIAF	ZonMw impact assessment framework

Summary

Background

The field of nutrition underwent a significant transformation since the 1970s with the emergence of food mass production, leading to increased access to and affordability of food products and a decline in global malnutrition rates. This caused an increase in inexpensive and unhealthy food options, contributing to unhealthy eating behaviours and an increase in non-communicable diseases. The prevalence of obesity worldwide has nearly tripled since 1975, increasing the need for a more holistic approach to nutritional research that considers the complex interplay between different diets and their impact on physical and mental health. To navigate this complexity, transdisciplinary collaborations and international research networks have become crucial in nutritional science. The Joint Programming Initiative "A Healthy Diet for a Healthy Life" (JPI HDHL) is an EU-wide initiative that facilitates and funds nutritional research. The initiative aims to align national strategies, fund research, and promote knowledge implementation through collaborations with governmental agencies and research institutions. However, the first JPI HDHL-coordinated research project only started 12 years ago. Before applying research outcomes from this initiative to participating members from the European Union, it is essential to assess the impact of these projects first. Understanding the impact of these project outcomes on policymaking and research is vital for future funding, resource allocation, and the overall relevance of the initiative.

Aim

In this study, the term “impact” is defined as knowledge utilisation, the information gained from these projects should be utilised by researchers, educators and policymakers in the field to be deemed impactful. To determine whether the target audience can implement research outputs, it is crucial to assess how project structure and management affect knowledge production, which in turn affects knowledge dissemination and usage by target stakeholders. Therefore, the research question put forward in this study is “What impact have JPI HDHL projects generated in the field of nutrition in relation to the research program structure and management?”. Additionally, the two project types JPI HDHL coordinates, traditional call projects and knowledge hubs, were compared to identify if the difference in structure and management affects knowledge utilisation. Traditional calls are research projects aiming to produce new knowledge, while knowledge hubs are platforms where pre-existing knowledge is gathered and assessed. The aim of the former is to produce new knowledge by discovering a new phenomenon or creating a new method or tool. In contrast, the latter aims to cluster knowledge produced by traditional calls, which can then be implemented in other sectors, such as policy or industry.

Methodology

Indicators from the ZonMw impact assessment framework were utilised to measure the impact of these projects. With these indicators, it is possible to assess the overall quality of a research project by looking at its different aspects, such as partner collaboration, project innovation, co-financing, result presentation and dissemination etc. A mixed methods approach was chosen to answer the research

question mentioned above. First, online interviews were conducted with project coordinators from completed JPI HDHL projects to gain insights into how these projects were coordinated, what type of results were produced and how these were disseminated and what the thought process was behind these decisions. The results from the interviews were used to develop a survey. This sequential design aimed to identify the most and least significant indicators contributing to project impact and establish the relationship between these indicators and impact generation. The questionnaire was sent to project coordinators as well as all project researchers to include the insights and opinions of all project participants. Out of 45 eligible projects, 14 participated in the interviews, while 28 participated in the survey. For data analysis, the interview transcripts were coded and clustered into relevant themes corresponding to the interview topics. The qualitative study was conducted using ATLAS.ti, following a bottom-up approach. The survey data was analysed using RStudio, with a descriptive analysis summarising the findings and a statistical analysis comparing the framework indicators between the two project types JPI HDHL coordinates.

Results & discussion

This study found that productive collaboration among specialised partners leads to high-quality and innovative research. Researchers effectively utilise various mediums to convey their results and dissemination routes to communicate these results, with scientific publications and websites being the most effective mediums. Almost half of the respondents use project data and newly developed tools from these JPI HDL projects in follow-up research. Indicators like project financing, innovation, and replicability are consistent across all projects. Comparing traditional calls and knowledge hub projects shows that the latter employ a wider variety of knowledge products and more dissemination routes. Knowledge hubs face challenges in managing larger partnerships but reach stakeholders beyond science better. Occasionally, traditional call projects struggle to assess results utilisation due to limited stakeholder collaboration. In some instances, resource limitations affect dissemination in traditional calls, but both project types successfully reach their target audiences. Statistical analysis found no significant differences between project types and the tested framework indicators. This study's strengths include the sequential design of the methodology, which increased the efficiency and effectiveness of the survey. The high project participation rate is another strength, although the survey response rate is low due to limited email access. The exclusion of long-term impact measurements is another limitation, as most projects ended between 7 and 2 years ago, which is too short to assess the real-world implications of these results. Overall, this study shows that JPI HDHL-funded projects achieve a high degree of impact due to the high quality of research, unique consortia with specialised knowledge, varied mediums used to present and disseminate project results and good project planning and management. Future studies could include stakeholders beyond science from the start of the project to disseminate to these sectors even further.

Introduction

In the 1970s, the field of nutrition was revolutionised by the emergence of food mass production[1]. Rapid economic development, modernisation of food processing techniques, and agricultural advances made it possible to increase the access and affordability of many food products, leading to a decline in malnutrition rates worldwide[2]. Regardless of this development, malnutrition remains a prominent issue, with 1 in 10 people suffering from hunger and 1 in 3 people lacking regular access to adequate food worldwide in 2020[3]. Due to this increased access to food sources, inexpensive and unhealthy food options have become more prevalent than ever. Additionally, in many regions of the world, such as North America and South-East Asia, healthy food sources are increasingly more difficult to access compared to unhealthy sources. Such areas, also known as “food deserts”, contribute to the increasing behaviour of eating unhealthily[4,5].

These developments shifted the prominence of nutrition-related health conditions from single nutrient deficiencies to non-communicable diseases, such as type 2 diabetes, obesity and cancer. Worldwide obesity rates have nearly tripled since 1975, with 1.9 billion adults being overweight and 650 million being obese in 2016[6]. As such, although advancements in food development ensured that accessibility to nutrition increased, it has also caused many health problems. The increased prevalence of chronic diseases shifted nutritional research from simple metrics, such as saturated fat and energy density, to the more intricate influence of different diets on physical and mental health, tackling nutritional research from a more holistic point of view. While the effects of nutrition on humans have been studied for centuries, modern nutritional research is a relatively new scientific field[7]. Due to the ever-developing agricultural and food businesses, nutritional science must keep up with these recent developments. Furthermore, due to the addition of new chemicals and compounds to the food production process, it is also crucial to establish the long-term effects of new food manufacturing technologies on health[2]. As a result of these developments, the nutritional research field has become more complex, increasing the need for transdisciplinary collaborations[8]. Because of this increased complexity, the appeal to share resources and collaborate cross-nationally between project funders, research institutes, universities, NGOs, and other stakeholders has grown. For this reason, research networks that extend national borders are crucial in nutritional science[9].

Next to the increased incentive for collaboration, there is an increased need for more efficient and effective research methodologies[10]. New nutrition studies should be modelled using knowledge and methods from previous studies that fit the exact purpose of new studies. Additionally, new projects should stimulate transformative action to change nutritional policy by influencing new policymaking in the field of nutrition[10]. In short, it is necessary to influence new policymaking for transformative action. However, it is first necessary to understand the impact of nutritional research. In this case, impact is defined as the change an action (nutrition-related research) created. Are the results from a study implemented in new research or other areas? Which studies were impactful? Which studies were not and why? Assessing the impact of nutritional research is a crucial step in advancing nutritional science, which ultimately aims to decrease the burden of malnutrition and nutrition-related diseases worldwide.

One initiative that facilitates and funds nutritional research is the Joint Programming Initiative “A Healthy Diet for a Healthy Life” (JPI HDHL). Joint programming initiatives were defined in 2008 by the European Commission to address societal, cultural, health- and climate-related challenges in Europe. This is achieved by pooling resources from member countries to perform research more efficiently and effectively[11].

JPI HDHL, with the secretariat located at the Dutch national health funding agency ‘ZonMw’ in the Netherlands, brings together 26 European countries, including Canada, the United Kingdom and Israel outside the European Union, that collaborate and fund new research to prevent diet-related diseases. Research coordinated by JPI HDHL is conducted all around Europe, and the results and knowledge are used to influence research and policy in all the participating nations. The initiative also works on a programmed approach to align national research and innovation strategies and fund new research to facilitate a proper understanding of the relationship between physical activity, diet and health[12]. ZonMw and JPI HDHL invest a lot of time and effort in implementing knowledge created by these projects. By working with governmental agencies and many different European research institutions, ZonMw and JPI HDHL can provide insights on new policies and novel research strategies, increasing the impact projects have in the file of nutrition[13]. In 2020, the independent consultancy firm Technopolis Group performed an impact assessment of JPI HDHL to assess the functioning of the initiative. Nevertheless, such an assessment has not been completed for the research projects under this initiative[13]. For research to be impactful, it must create (positive) change in the scientific community or broader society. Knowing whether the projects funded by this initiative produce results that are used in policymaking or research is relevant to raise future funds and resources and influences the future direction and relevance of this initiative. Without knowing the impact, it is impossible to determine if and how this initiative's research affects our lives[10].

Additionally, JPI HDHL funds two types of research projects, traditional calls and knowledge hubs. Traditional calls are conventional research projects that aim to produce new knowledge, which could be in the form of studying a new phenomenon, developing novel methodologies or interventions etc. In contrast, knowledge hubs are platforms where pre-existing knowledge from regular research projects is gathered, assessed, and implemented into new scientific research or sectors beyond science. To determine the impact of JPI HDHL-funded projects, it is also important to evaluate how these two different project types are structured, managed and how these differences may lead to varying forms of impact. Research determining the scope of impact of these project types by comparing the differences in structure and management is currently lacking.

This study aims to bridge this knowledge gap and has two aims. The first aim is to determine whether the **results and knowledge of completed projects of JPI HDHL are of sufficient quality to impact policy or uptake in practice.** The second aim is to determine whether projects within JPI HDHL **are being structured and conducted efficiently and effectively to ensure the highest level of impact**. To reach these aims, an impact assessment (IA) of completed projects will be performed using the ZonMw Impact Assessment Framework. JPI HDHL will use the results of this study to assess the scope of impact of their studies in the field of nutritional research and could contribute to future policy and guideline decision-making.

Research questions & objective

The research questions of this study are:

- What impact have JPI HDHL projects generated in the field of nutrition in relation to the research program structure and management?
- Is there a difference in impact generation between traditional call and knowledge hub projects, and if so, to which degree?

The research objective is to establish the impact of JPI HDHL projects in the field of nutritional science by performing an impact assessment of completed projects which will be achieved by interviewing and surveying different project partners.

Contextual background

In the next section, the background and context this project is based on will be further discussed. This will include more information on assessing impact in general and on the organisations JPI HDHL and ZonMw.

Knowledge implementation; history and challenges

The implementation of research in practice has been challenging for decades. In recent decades, evidence-based medicine increased the quality of scientific research, leading to improved methodologies and a patient-focused care approach. This increased quality and standardisation of methods led to the exponential increase in research output we see today[14]. The pace at which medical research advances is far greater than the pace at which research can be implemented and adapted to society. Historically, the desire of the scientific community to produce new knowledge was more significant than applying knowledge to the field[15]. Nowadays, such a philosophy means that less than 50% of all clinical innovations are applied to the general public and that 80% of the money invested in medical research does not lead to scientific advancements used for public benefit[16]. While scientific impact can be reached using generated knowledge as a foundation for new studies, societal impact is more difficult to achieve and measure. On average, it takes 17 years before research output affects society[17]. The lag between information generation and implementation cannot solely be attributed to the scientific agenda, as many factors causing this delay are contextual and unrelated to the clinical innovation itself[18]. All relevant stakeholders, from research institutes to national and local governmental bodies, are responsible for implementing research findings. Factors like safety, cost-effectiveness, cultural or religious beliefs, public perceptions, and much more must be aligned for science to affect change[18]. Effective clinical trials do not guarantee that a scientific breakthrough will impact society. While it is essential to perform research, it is equally important to understand whether the end product is creating any form of change. Understanding the impact of an action makes it possible to determine if the required resources are worth the investment and if the action (research) causes any positive or negative (health) outcomes[19]. This knowledge will then be used to shape new research or policy, creating an iterative process that will ultimately lead to a scientific advancement that will benefit society as a whole[20]. The growing need for accountability and the desire for improvement within scientific research has created the novel field of implementation science[19,21]. In short, implementation science aims to measure the health impact created by a study and tackle potential barriers that hinder knowledge uptake[21].

Knowledge implementation in nutritional science

Implementation science is a relatively new addition to nutritional research. The field of nutrition science suffers from the same implementation issues mentioned above, as most of the produced knowledge is not utilised in research or policy[22]. While nutritional research has been conducted for over 100 years, the translation of research into policy has only occurred in the past 25 years[22]. This trend developed after the 1986 International Conference on Health Promotion in Ottawa, where a growing need for public

health promotion was established. In this convention, health was defined as a lack of disease, which the health sector is responsible for, but as a state of complete well-being, to which all of society contributes. This way of thinking emphasises the importance of other aspects, such as nutrition, on health, increasing the need to translate scientific knowledge into policy[23]. In the decades that followed, the rate of knowledge generation in the field has increased drastically, while a universal and cohesive model for knowledge implementation remains missing[24].

Background of JPI HDHL

The goal of the Joint Programming Initiative 'A Healthy Diet for a Healthy Life' is to understand the complex role of nutrition on public health and to identify and prevent nutrition-related chronic diseases[12]. Within this initiative, 26 countries work together by sharing knowledge and resources to perform nutritional research more efficiently and effectively. The main advantages of this approach are that produced knowledge can easily be peer-reviewed by members from other countries and institutes, and that knowledge implementation can occur in all member states, which benefits the implementation and standardisation of new findings[25]. The ultimate goal of JPI HDHL is that *"…by 2030 all citizens will have the motivation, ability and opportunity to consume a healthy diet from a variety of foods, have healthy levels of physical activity and that the incidence of diet-related diseases will have decreased significantly*"[26]. Since the creation of this initiative over 12 years ago, more than 70 studies have been completed, with numerous funding calls and research projects still ongoing.

JPI HDHL supports two types of projects, namely traditional calls and knowledge hubs. Traditional calls are actual research projects aiming to produce new knowledge, while knowledge hubs are platforms where pre-existing knowledge is gathered and assessed. In the last decades, the number of nutritional studies increased exponentially, creating a need for networks dedicated to exchanging new developments in the field of nutrition[10,27]. After gathering information, these knowledge hubs aim to implement findings in policymaking or new research. In general, knowledge hub projects are larger in scale, with many different research institutes and stakeholders beyond science participating in these projects, while traditional calls are mainly made up of 2-7 research institutes and academic departments performing research. In this study, the impact of both traditional calls and knowledge hubs will be examined to determine whether there is a difference in impact generation between these two project setups. Additionally, JPI HDHL projects, being conducted and coordinated by 26 member countries, are all structured differently when comparing them to one another or the different programmes funded by ZonMw. Therefore, determining whether there is a significant difference in organisation and management between the different projects is crucial to assessing the overall impact these projects have on nutritional research.

Background of ZonMw

Now that we have a clear vision of the aim and structure of JPI HDHL, it is necessary to understand the role of ZonMw. ZonMw is a Dutch research funding agency that specialises in funding and coordinating health-related research in the Netherlands. They enable researchers and institutes to produce new

scientific knowledge while also identifying knowledge gaps in healthcare, not only in the Netherlands but internationally, through collaborations such as JPI HDHL[28]. The organisation participates in the JPI HDHL initiative on behalf of the Netherlands. The JPI HDHL secretariat, being located in the Netherlands, uses resources from ZonMw to operate.

How JPI HDHL & ZonMw define impact

At JPI HDHL and ZonMw impact is defined as **knowledge utilisation**. The information gained from a research project should be utilised by researchers, educators and policymakers in the field[29]. To determine whether knowledge can be utilised, it is important to assess how knowledge is generated. Therefore, determining how a project is planned and managed will provide insights on how knowledge is generated and utilised.

Impact can be further subdivided into societal and scientific impact. Societal impact is the implementation of knowledge and innovation in research, policy and education to achieve intended (behavioural) changes on the population level leading to better health outcomes. Scientific impact is the implementation of knowledge and innovation in research to improve skills and competencies, leading to better health outcomes[30]. To achieve high rates of knowledge implementation, ZonMw aids project leaders by providing relevant literature, targeted funding for knowledge implementation projects, and by providing counselling from an implementation expert.

Conceptual background

To measure the impact of JPI HDHL studies, it is important to first define some relevant concepts and to determine which criteria are going to be used to measure and assess research impact.

Defining impact

The term “impact” is widely used in modern society. Therefore, its definition can vary according to the setting it is used in. One commonly used definition was coined by the author Carol Taylor Fitz-Gibbon in 1996 and described impact as …”any effect of the service (or of an event or initiative) on an individual or group”[31]. According to this definition, the outcomes of an action can either be positive or negative. Therefore, when measuring impact, one measures the change of set action. Since 1996, this concept has been used, adapted and further specified by many different researchers and institutes. The Global Libraries Initiative from the Bill and Melinda Gates Foundation added to the definition of Fitz-Gibbon, creating a more modern definition of impact widely used today[32]. Their definition states that an impact:

- “may be wide-ranging, affecting many stakeholders from library staff to library users; from local government officials to local community groups, or;
- may be more specific, directly affecting only one group of stakeholders; and
- can occur on levels from the superficial to the life-changing”[32].

This definition will also be applied in this study.

Project planning, monitoring and evaluation

In the research setting, it is important to establish how the project was planned, monitored and evaluated to assess if it created any impact. Therefore, developing a knowledge implementation strategy is needed while the project is still in the planning stage[33]. Knowing where or how the produced information will be used can aid in the project's design, increasing the chance of knowledge utilisation after project completion. During the monitoring stage, it is possible to determine how well a project was implemented[33]. The likelihood that knowledge from a project will be used in the future is higher when the project is implemented and monitored properly. Similarly, evaluating a study makes it possible to establish whether the project objectives were achieved. These insights will aid in the development of new studies or policies[33]. In short, for a study to produce usable knowledge, it is important to establish how it was planned, monitored and evaluated.

ZonMw and JPI HDHL focus on all three steps to ensure that new research produces impact. During the planning phase, projects are reviewed to determine if they will investigate a topic that is 1) relevant to the field of nutrition and 2) if the outline and proposed methodology is of high quality. At this stage, the relevance and quality are assessed using **‘responsible research practices’** (RRP), while ongoing projects are monitored using **‘productive interactions’** (PI). These two concepts form the core of IA at ZonMw and will be further elaborated in the next sections[29].

Responsible research practices

To ensure that research projects achieve a high degree of impact, it is of importance that projects are 1) of societal relevance and 2) of high scientific quality. A project that is not relevant to society will not contribute to the development of a needed health solution, while a study that is not performed with a high scientific standard will not produce results that can be easily validated or reproduced[34]. The most important concept for measuring societal relevance is participation. Who are the relevant project partners and stakeholders, and what do they contribute to the project? Is there a way external parties can access information or contribute to a project? How diverse is the composition of project members? These are all questions that contribute to the societal relevance of a study. When it comes to scientific quality, various indicators could provide valuable insights into this aspect. Innovative methodologies and practice-oriented research increase the quality of a study[34]. Next to relevance and scientific quality, two other factors contribute to a study's overall quality, being integrity and efficiency. Ensuring that a project remains transparent and uses existing research to model its study greatly increases the chance it will produce impact[29]. ZonMw designed the "Fostering Responsible Research Practices" table that contains all relevant criteria, which can be seen in Table 1.

Table 1: ZonMw Fostering Responsible Research Practices criteria table. Criteria marked with an asterisk (*) are also indicators of productive interactions.

Societal relevance	**Quality**		
	Scientific quality	**Integrity**	**Efficiency**
Stakeholder participation*	Innovation of methodology	Transparency/Openness of research/ (pre)registration	Use of existing data/eResearch/ citizen science
Co-financing*	Diversity in research content	Replication (research)	Encouraging systematic reviews/ knowledge syntheses
Diverse composition of steering committee	Practice-oriented research (HBO, MBO[6])	Preventing publication bias	Appropriate (alternative) designs
Holistic health concepts	Pioneering/Innovative research	Training and quality assurance	Dealing with (potential) inclusion or operational problems
Participative knowledge infrastructure	Interdisciplinary and international cooperation and knowledge development	Conflicting positions/ interests	Efficient arrangement of programming processes
Added value of knowledge in practice, policy and education*	Diversity/Variety of assessment process		
	Variety of (transfer of) output*		

Productive interactions

Productive interactions are one of the most important indicators when determining the impact of a study. They provide information on essential aspects that lead to behavioural changes, which increase the likelihood of knowledge utilisation[29]. These four predictive indicators are the primary tools used in ZonMw impact studies and this project in particular. The indicators are:

- Collaboration with relevant partners/stakeholders
- Co-financing
- Delivery of usable knowledge products
- Targeted dissemination and implementation activities

Some indicators, such as the 'collaboration between relevant partners' overlap with indicators from the fostering responsible research practices table. In this case, "partners" refers to all individuals involved in a project, for example, the government, researchers, public and/or private organisations and the public. Collaborations between these partners can be direct, like the face-to-face exchange of information, but also indirect, like electronic communication or communication through publications. To determine the impact of a study, it is important to assess which partners were involved in a project and how they communicated[35]. Furthermore, co-financing increases the number of involved partners, which could be both from the public and private sector, in a project, leading to more communication, collaboration and potentially more knowledge implementation since all involved partners are interested in the outcome. The delivery of usable knowledge products is another important indicator. A research project could be designed and executed with high quality, however, if the study did not produce usable and relevant results, it did not contribute to a potential research target. Lastly, before starting a research project, it should be clear where and how the produced knowledge will be used. Having a targeted approach when it comes to knowledge utilisation greatly increases the chance of implementation[35].

Theoretical framework

This section will elaborate on the conceptual framework used in this study. Additionally, answering the research question will require answering a sub-question first. Information on how the framework will be used to answer this sub-question will also be explained.

Explanation of framework

The ZonMw impact assessment framework (ZIAF) was chosen for this study. This model was created and introduced in 2019, and since then, it has been utilised by ZonMw to assess the impact of funded projects. However, due to the COVID-19 pandemic, the framework has not been extensively used yet, since scientific research progress slowed down during the pandemic. Nevertheless, this model was chosen due to the inclusion and integration of both the RRP and PI criteria, which no other impact assessment framework does to this extent. Additionally, since many JPI HDHL projects are selected and funded based on these criteria, it will be of interest to use this framework to validate whether including these criteria in research projects affects impact generation. Besides, another less relevant advantage of using this framework is to validate its effectiveness since it has not been used extensively yet.

As seen in Figure 1, the planning, monitoring and evaluation phases are represented in successional order in the grey columns. For each step, the relevant PIs are highlighted in the dark grey section in the middle, and the RRP criteria, light grey, apply to the entirety of the research cycle. The most important aspects of the planning phase are to establish the project and impact goals. All relevant partners will define these goals, including the type and amount of resources that will be invested in the project. During the monitoring stage, these goals will be pursued through the implementation of RRP and active collaboration between partners. Finally, generated knowledge will be disseminated and implemented in new studies or policies after project completion. For the scope of this project, the three study levels (cluster, project and programme) will not be considered. JPI HDHL projects, being conducted and coordinated by 26 different member countries, are all structured differently when comparing them to one another or to the different programmes funded by ZonMw. This makes it challenging to perform meaningful comparisons, which is necessary when assessing impact. Nevertheless, this study will analyse the specific indicators per research phase to determine if the implemented indicators contributed to impact generation.

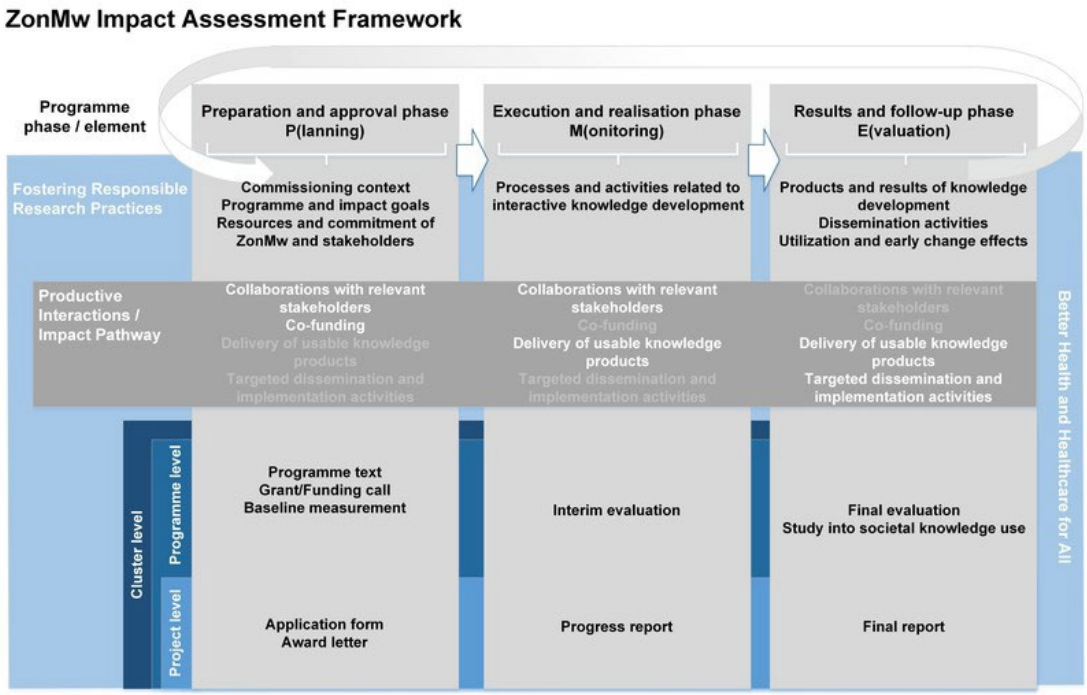

Figure 1: The ZonMw Impact Assessment Framework, describing the different steps of research projects and the corresponding areas of interest when assessing their impact.

Besides including the ZIAF in this study, JPI HDHL also formulated general indicators to assess the research projects before and after their completion. The indicators that are specifically relevant to evaluate project impact will be included in this study and are summarised in Table 2. Most of these indicators correspond to those stated in the RRP table and ZIAF framework. However, differing indicators such as 'target groups' and 'policies' will be included in this study as well.

Table 2: General indicators used by JPI HDHL to assess the impact of funded research projects, including some example questions per indicator.

Transfer of scientific results into practice	
Industry collaboration	• Did the data generated by the project lead to new industry collaboration? • If yes, what is the size of the company? • Is the company willing to give some financial support to further projects?
Development of new methods, frameworks, tools	• Has the consortium created new methods, questionnaires, analyses framework etc. to be used in subsequent research approaches? • Have new findings been communicated/disseminated to other target groups (policy makers, other research consortia)? • How did this research project contribute to the coordination of research activities in this field, e.g. development of better standards and harmonized methods ?
New strategies, products, interventions	• Have the results led to the development of new strategies to reduce incidence of diet related chronic disease? • Have the results led to the development of new strategies to enhance European competitiveness?
Target groups	• Which target groups benefit from your research (consumers, patients, politicians, scientists (researchers, clinicians)?
Policies	• Are there some research results that could induce changes in the food and drinks sector?

Research sub-question

To iterate, the research questions of this study are:

- What impact have JPI HDHL projects generated in the field of nutrition in relation to the research program structure and management?
- Is there a difference in impact generation between traditional call and knowledge hub projects, and if so, to which degree?

To answer the main research questions, one sub-question needs to be addressed first:

- Which responsible research practices and productive interactions were applied to the research projects and how did these affect impact generation?

To determine whether the research projects generated any impact, it is important to establish which RRP and PI indicators were used and how these affected the generation and implementation of knowledge throughout the project. Therefore, answering the sub-question will be crucial to assess the overall impact of JPI HDHL projects.

JPI HDHL funds and coordinates two different project types, knowledge hubs and traditional calls. Due to the difference in project aim, the former being the collection and implementation of existing knowledge into research or policy and the latter being the generation of new knowledge through evidence-based research, it is essential to see how the difference in project structure affects impact generation. Establishing which and how RRP and PI indicators are applied to both project types will provide some insight into the impact of these projects, as well as indicators. Therefore, the second goal of this sub-question is to determine which indicators were taken into account during the planning, monitoring and evaluation phases for both project types and how these potential differences lead to different forms of impact.

Methodology

In this section, the study methodology will be discussed in more detail, including study population selection, data collection and data analysis procedures.

Study design

To answer the research questions, "*What impact have JPI HDHL projects generated in the field of nutrition in relation to the research program structure and management?*" and *"Is there a difference in impact generation between traditional call and knowledge hub projects, and if so, to which degree?"*, a mixed methods approach was chosen. First, online interviews were conducted with project coordinators. Next, a questionnaire was sent to more project coordinators and members from the same projects, as well as to members from other projects not included in the interviews.

Research projects and study population

In total, 45 research projects ended before 2023 and were thus eligible to participate in the survey and interviews. Of these, five projects were knowledge hubs, and 40 projects were traditional calls. After reaching out to the project coordinators and establishing their availability and willingness to participate in this study, a definitive selection of projects was made. For the interviews, three knowledge hubs and 11 traditional calls were chosen. The questionnaire was sent to the aforementioned project coordinators, as well as to coordinators and members from all other projects that were completed between 2016 and 2022.

As for the study population, the project coordinators from the selected projects were interviewed to explain and justify the progression and impact of their projects. After the interviews, a questionnaire was formulated and sent to all relevant researchers from completed JPI HDHL projects.

Data collection

The interviews were conducted in a semi-structured manner, allowing the discussion of new and relevant topics that emerged during the interviews. This approach also provided the flexibility to address some topics in more or less detail while at the same time maintaining the predetermined structure of the interviews[36]. Figure 2 shows the six overarching topics that were discussed. In the project details section, the project coordinator gave a brief overview of the project goals and how the project progressed throughout the data collection and analysis periods. Afterwards, the overall project performance was discussed. Here, the coordinator explained whether specific goals or hypotheses were met and the challenges the project faced. Lastly, the main topics discussed during the interviews were question-related to the PI and RRP indicators. The knowledge products and dissemination routes, being the most important PI and RRP indicators that have the biggest effect on project impact, were discussed in more detail compared to the other indicators. The remaining indicators featured in the interviews were partner collaboration, project innovation, co-financing, project transparency and project replicability. The complete interview guide can be seen in Appendix 2.

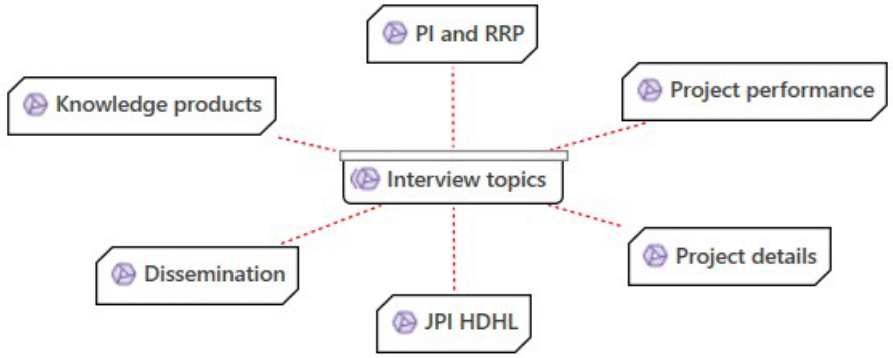

Figure 2: Main interview topics discussed during the interviews. The most important PI and RRP indicators, being the knowledge products and dissemination routes, were discussed independently and in more detail compared to the other indicators.

In short, to answer the research question, the interviewees were asked about the role and degree of communication between all partners, the added value of using existing data in their studies, the type of output produced by their research and the used dissemination and implementation strategies after the project end date. Due to the selected research projects being conducted across Europe, all interviews took place online using the online meetings platform Microsoft Teams. Depending on preference, interviewees had the option to speak in English, German, Dutch or Italian. Before the start of the interviews, the participants signed an informed consent form, agreeing to the interviews being recorded, transcribed and used in this study. The informed consent form can be seen in Appendix 3. The interview recordings were deleted after transcription.

The results from the interviews were used to develop the survey. Overall, the same topics that were discussed during the interviews were included in the survey, being the PI and RRP indicators, project planning and performance. However, since the survey was sent to a larger cohort of researchers and projects, it was crucial to identify which PI and RRP indicators or which unforeseen factors contributed the least and most to the impact of research projects. The interview results helped identify these factors, making it possible to develop a more efficient and effective survey. The sequential design also made it possible to validate the outcomes of the interviews further. Moreover, the survey made it possible to determine the relationship between the most relevant PI and RRP indicators obtained through interviews and impact generation. Most of the survey questions required a five-point Likert scale answer, providing some nuance on the importance and relevance of the answer. However, some multiple-choice and open-answer questions were included as well. Lastly, the survey was distributed via e-mail and was formulated in English. Since the e-mail addresses of all partners involved in a project were only available for some eligible projects, project coordinators were kindly asked to forward the survey to all involved partners. The complete survey can be seen in Appendix 4. In short, the goal of the interviews was to assess which PI and RRP indicators were applied in research and to which success, while the purpose of the survey was to validate the interview results and to determine project impact.

Data analysis

Data collected from the interviews was transcribed and coded following the six steps of qualitative data analysis from Creswell[37]. In the first step, data was transcribed and prepared for data analysis. After data transcription, the transcripts were coded. The generated codes were clustered into relevant themes, which formed a 'qualitative narrative'. The main themes corresponded to the interview topics and can be seen in Figure 2. Lastly, using this narrative, the data was interpreted[37]. Qualitative data analysis was performed using ATLAS.ti, and the transcriptions were coded using a bottom-up approach. This approach made it possible to determine which PI and RRP indicators were used per project and to see why and how these indicators contributed to knowledge utilisation across all selected projects. The complete code tree used for the qualitative analysis can be seen in Appendix 5.

Data gathered from the survey was analysed using the program RStudio. First, a descriptive analysis was performed to summarise the findings and to determine the prevalence of all answers. Furthermore, a statistical analysis was executed to determine whether there was a difference between knowledge hubs and traditional call projects. In this analysis, both project types were compared to variables taken from the survey answers. They included variables on how the projects were planned and executed, what knowledge products and dissemination routes were used and which mediums proved to be the most effective, results usage by the target audience etc. A list of all tested variables and their corresponding survey questions can be found in Table 3.

Table 3: Survey questions and their assigned variable names used to perform a statistical analysis, with the aim to compare both project types.

Survey question	Variable name
During project planning it was clear which knowledge products would be delivered.	Knowledge products planning
During project planning it was clear how knowledge products would be disseminated.	Dissemination route planning
The knowledge product(s) were chosen based on the needs/requirements of the intended target audience.	Knowledge product choice
The knowledge product(s) reached the intended target audience.	Knowledge product reach
The knowledge product is being/has been used by the intended target audience.	Knowledge product use
What is the target audience experience of using the product?	Target audience experience
I am satisfied with the amount of impact my project created in its intended field.	Impact satisfaction
The participating partners provided unique expertise or skills that were needed to complete the project.	Partner expertise
The compulsory or desirable co-financing structure was of added value to the project.	Co-financing structure
Participating in an initiative such as JPI HDHL increases the amount of impact a research project has when compared to projects without such an affiliation.	JPI HDHL impact

The answers to these survey questions were based on the five-point Likert scale, and the text-based answers were translated to a numeric value for analysis. The answers "strongly disagree", "disagree", "don't know", "agree", "strongly agree", and "N/A" (not applicable) were assigned the values 1, 2, 3, 4, 5 and 0, respectively. Since the aim is to compare two groups, namely traditional calls and knowledge hubs, the groups are independent, and the Likert scale is classified as categorical data and organised

in an ordinal way, a chi-square test was initially chosen. However, not all outcomes were represented by five observations, therefore, a Fisher exact test was ultimately performed. For this analysis, a significant a-value of 0.05 was selected.

Ethical consideration

No additional ethical approval was deemed necessary after completing the BETHCIE ethical review self-check.

Results

The main findings from the qualitative and quantitative data analysis will be highlighted in this chapter. These results will be utilised to answer the main research questions: *"What impact have JPI HDHL projects generated in the field of nutrition in relation to the research program structure and management?"* and *"Is there a difference in impact generation between traditional call and knowledge hub projects, and if so, to which degree?".*

Participant characteristics

The respondent characteristics of the survey are presented in Figure 3. Over 133 project coordinators and members were invited to complete the survey. Establishing how many individuals received the survey was challenging, as project coordinators were encouraged to forward the survey to all members involved in their projects. However, the complete list of email addresses for all project members was only available for a few projects. On average, each project consisted of 20 project members, although this varied depending on the consortium size. If all project coordinators had forwarded the survey to all project members, which is unlikely, the estimated total population size would be around 900 individuals. Out of the 133 researchers who received direct invitations, 56 responded, and 55 responses were included in the analysis.

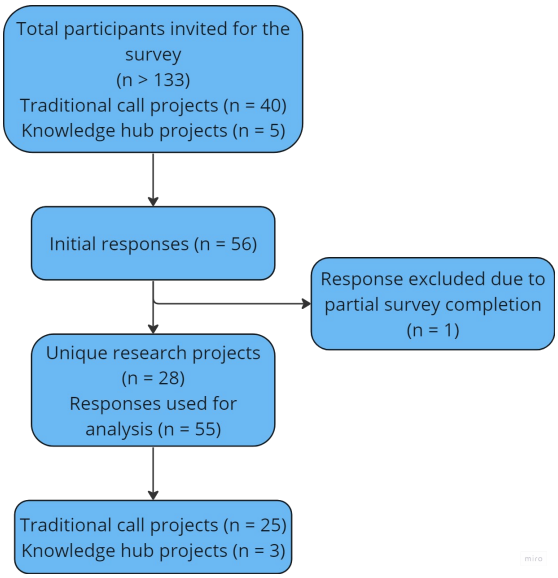

Figure 3: Flowchart summarising the respondents and project characteristics from the survey responses.

The participant characteristics for the interviews are summarised in Figure 4. In total, 45 research projects were eligible for participation in the. Of these 45 invited research projects, 15 project coordinators expressed interest in participating in the study. One project was excluded from the interviews due to availability and scheduling issues.

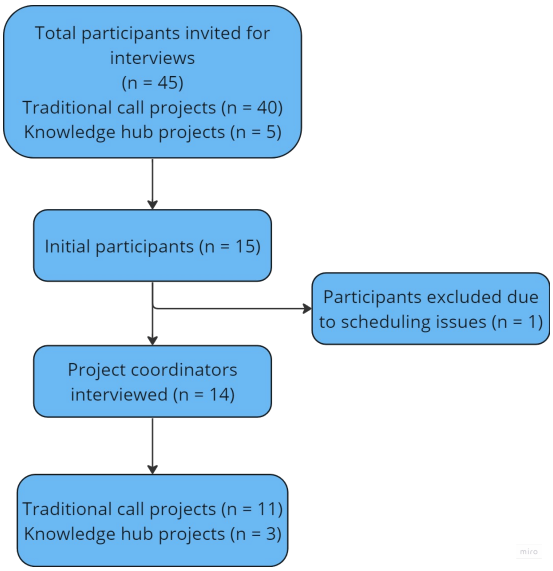

Figure 4: Flowchart summarising the participant and project characteristics included in the interviews.

PI and RRP indicators

Knowledge products

When considering the overall frequency of knowledge products disseminated, it is evident that all respondents published articles in academic journals. Other commonly utilised mediums included project websites, lectures, and protocols or guidelines. Figure 5 provides an overview of the knowledge products employed by participants in interviews and surveys. In contrast to the interview results, approximately one-third of survey respondents reported using articles intended for the general public. Overall, a diverse range of knowledge products was utilised by both interviewees and survey participants, although not all mediums were used with equal frequency. Traditional channels, such as scientific publications and lectures, were the most frequently used.

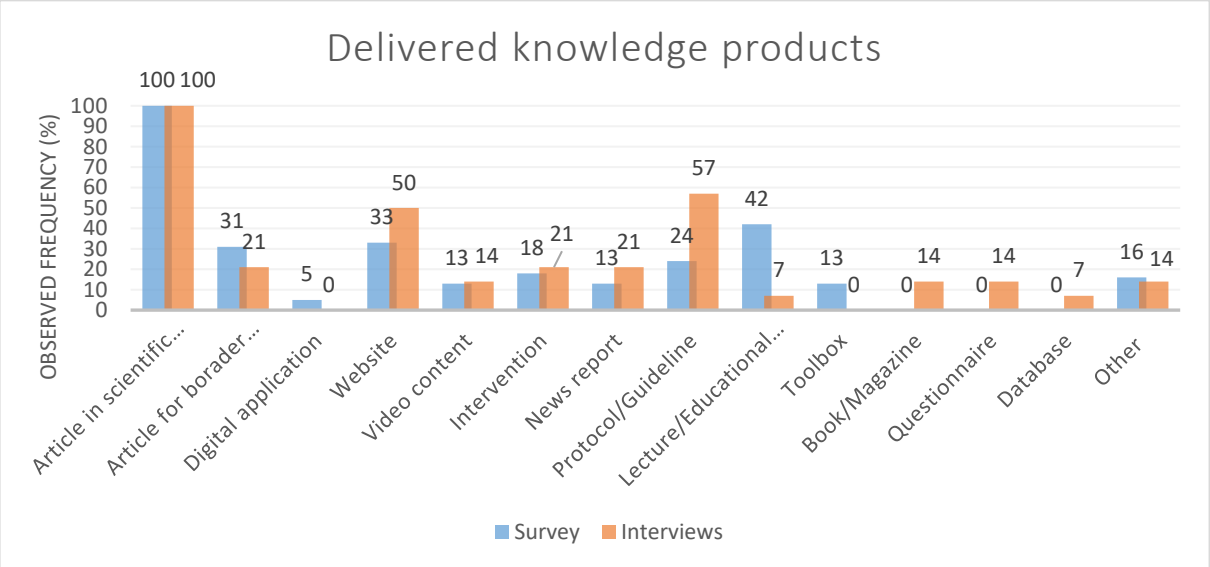

Figure 5: Overview of all delivered knowledge products, including the observed frequency (in %) for both interview and survey respondents.

During the interviews, project coordinators were asked about the medium they considered most effective for presenting their project results. Figure 6 shows an overview of the most effective knowledge products, with the most effective options listed at the top and the least effective or least frequently mentioned options listed at the bottom. The figure reveals that scientific articles, lectures, and project websites are the most effective means of conveying project results. The frequency of chosen knowledge products aligns with the perceived effectiveness of these mediums by the project coordinators, as the most effective mediums were selected more frequently than the less effective ones.

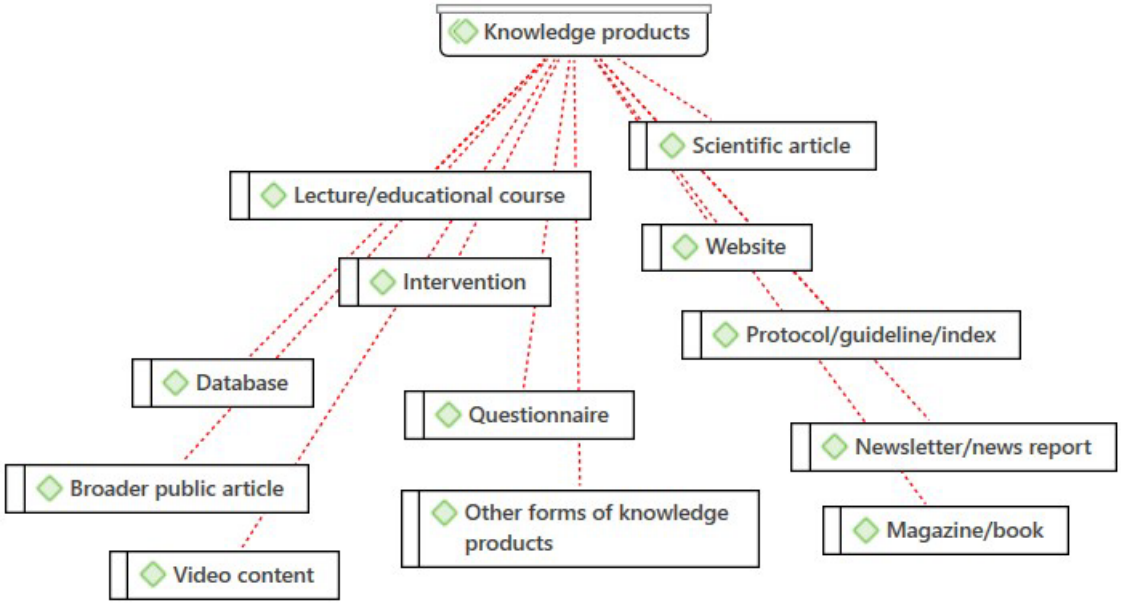

Figure 6: Flowchart indicating the most effective knowledge products used by the interviewed projects, according to the project coordinators. The mediums towards the top, closest to the title, were the most effective mediums, while those towards the bottom were the least effective.

Dissemination routes

The most commonly used dissemination routes were academic journal publications and conferences, with the former being utilised by all interview and survey participants and the latter by 13 interviewees and 46 survey respondents. Additionally, peer-to-peer communication, project websites, social media channels, follow-up projects, and courses or workshops were utilised by various project members. Figure 7 presents an overview of the dissemination routes used by interview and survey participants.

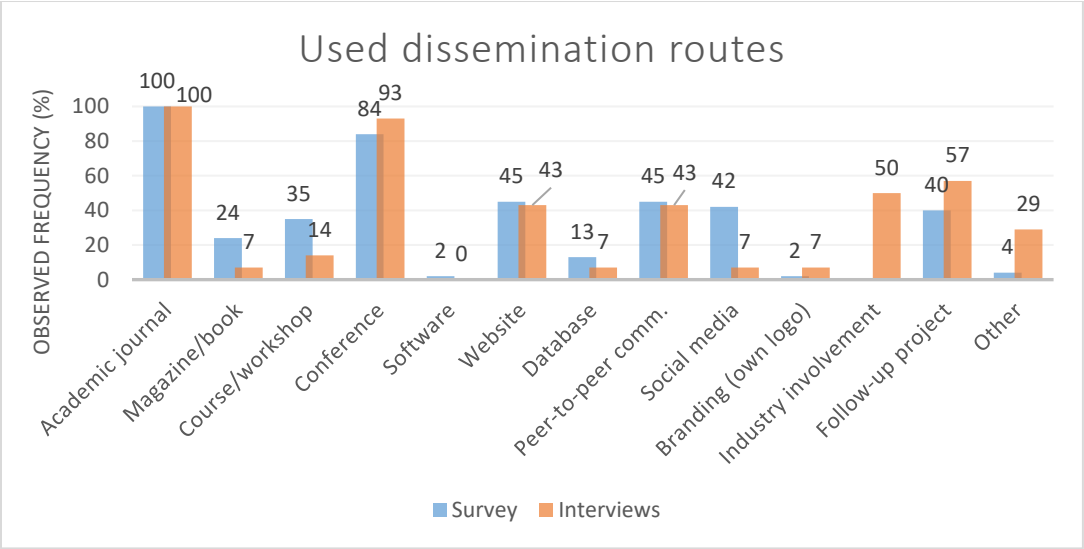

Figure 7: Overview of all used dissemination routes, including the overall observed frequency (in %) for both interview and survey respondents.

Similarly, during the interviews, project coordinators were asked to identify the most effective dissemination route for their specific project. Figure 8 illustrates an overview of the most effective dissemination routes, with the most effective options listed at the top and the least effective or least frequently mentioned options listed at the bottom. According to the project coordinators, scientific publications and conferences proved to be the most effective means of disseminating results. These mediums were closely followed by peer-to-peer communication and follow-up projects. The coordinators' perceived effectiveness of these dissemination routes corresponds with the frequency of their utilisation, indicating that more effective routes were utilised more frequently than less effective ones.

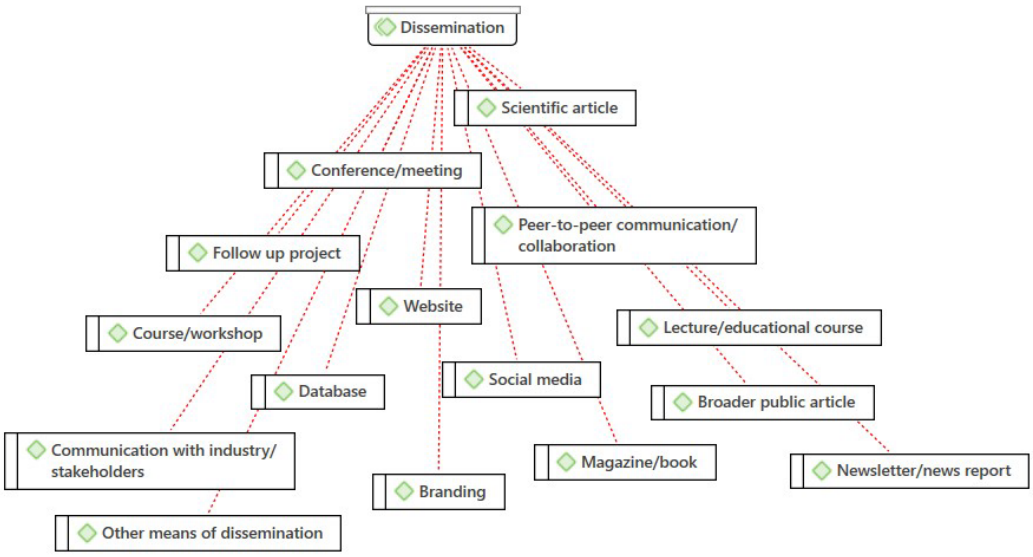

Figure 8: Flowchart indicating the most effective dissemination routes used by the interviewed projects, according to the project coordinators. The mediums towards the top, closest to the title, were the most effective mediums, while those towards the bottom were the least effective.

Partner collaboration

Overall, the collaboration between partners in all projects was very productive. The project consortia were made up of partners specialised in different areas that added to the quality of the research. Often, these partners were the leading experts in their field, bringing together unique consortia that were able to discover new phenomena and optimise novel methodologies using their expertise.

"All these groups have skills which were complementary to each other, allowing us to set up a unique consortium of folks that were extremely skilled and talented to run their part of the scientific analysis."
– Traditional call coordinator.

Figure 9 shows all survey participants unanimously agreeing when asked whether the unique expertise of project partners was needed to complete their project.

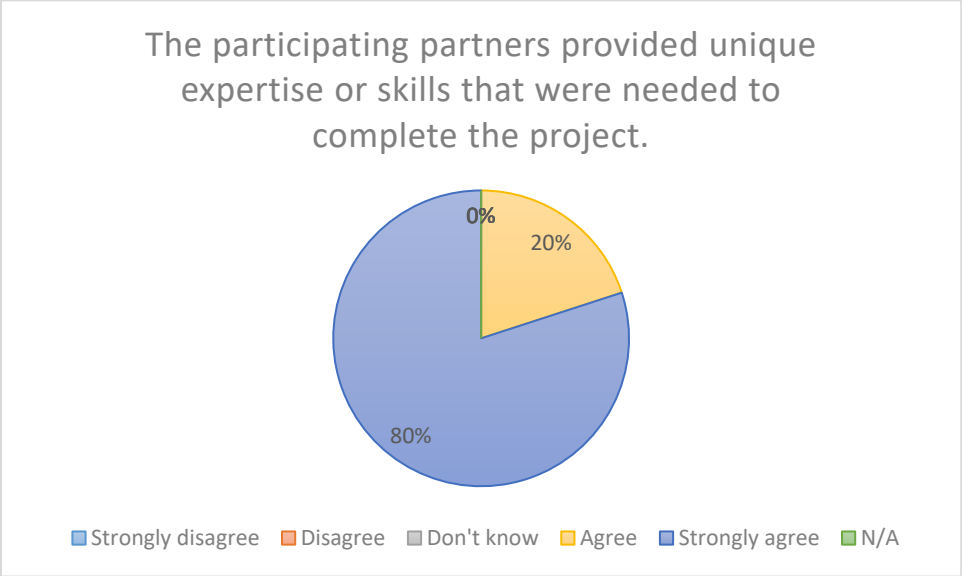

Figure 9: Bar chart indicating the survey answers to whether partner expertise was important to the project.

Project co-financing

All projects included in this study were required to obtain their funding through their respective national health research funding agency.

“Usually, one of the biggest issues coordinating a project is securing funding, you know. The fact that each country organised their own funding through their national agency was great, as a coordinator you can’t give more or less money to a specific partner, keeping it fair and everybody happy.”
– Traditional call coordinator

None of the interviewed project coordinators experienced any conflict of interest between the participating partners regarding funding. However, most of the coordinators mentioned that by the end of the 3-year project timeframe, there was not enough funding left to analyse all obtained data or

disseminate beyond the planned routes. This was mainly due to the COVID-19 pandemic, which caused delays to the data collection phase of almost all projects, resulting in lost time and investments.

Project innovation, transparency & replicability

During the interviews, project coordinators were asked in what way their project was novel or innovative, with one of the following three answers being replied by nearly all coordinators;

- the project utilised or developed a novel methodology that was more accurate or efficient than more established methods;
- the project discovered new phenomena like biomarkers or produced new interventions that were more successful or efficient than more established approaches;
- the project optimised or further validated new and improved methodologies that still needed to be peer-reviewed.

"So when we started out with this project, I think there were maybe one or two groups in the world using a similar approach, and now, several years later, there are probably between 10 or 20 different groups following this method, so it's taking off." - Traditional call coordinator

Additionally, all project coordinators structured their projects in a way that made it possible for peers to replicate their research by solely referring to the public, academic publications or openly accessible guidelines, protocols etc. However, three project coordinators mentioned that, in some cases, it is difficult to ensure complete transparency without compromising the intellectual property the project has over a discovery.

"We tried to make the methodology that we are using as transparent as possible. The issue is that if you want to develop biomarkers in a way that they can be widely applied, you, at some point, will need the protection of intellectual property that makes it interesting enough for companies to invest and to make these things available on a wider scale." – Traditional call coordinator.

Project performance

Topics that were not covered by specific ZIAF indicators but were still relevant when measuring project impact revolved around project planning and management, utilisation of results by the target audience and follow-up projects. The majority of projects underwent careful planning, with detailed research proposals being approved by JPI HDHL prior to project start. Additionally, all projects included in this study did not encounter difficulties adhering to their proposals or faced management challenges. However, several projects had to request a one-year extension due to the COVID-19 pandemic, which imposed restrictions on on-site research activities, leading to a pause in work that could not be carried out remotely.

Furthermore, participants in the interviews and surveys were asked about their awareness of the stakeholders utilising their knowledge products and their experiences with such knowledge. Unfortunately, a significant majority of respondents were unable to provide clear answers to this

question. For researchers, it was challenging to assess the utilisation of their knowledge once it had been published, as they lacked insights into specific website access, database usage, or readership of academic journals. Projects that involved stakeholders outside the scientific community from the project's start had the advantage of direct communication with these stakeholders and could provide insights into how these individuals applied the project results in practice.

"Involving stakeholders in the various meetings (helped to inform us) if our approach works for them. You cannot implement this knowledge without the stakeholders. We invited them, discussed our results with them and learned how to include these results in their work." – Knowledge hub coordinator.

Lastly, an additional factor not included in the ZIAF indicators or interview guide, but found to be significant in generating project impact, was the existence of follow-up projects. Many interviewed project coordinators used data or tools developed during their completed JPI HDHL projects in new research projects. The same was observed among survey respondents, shown in Figure 10, where 49% used data obtained from JPI HDHL-funded projects in new projects.

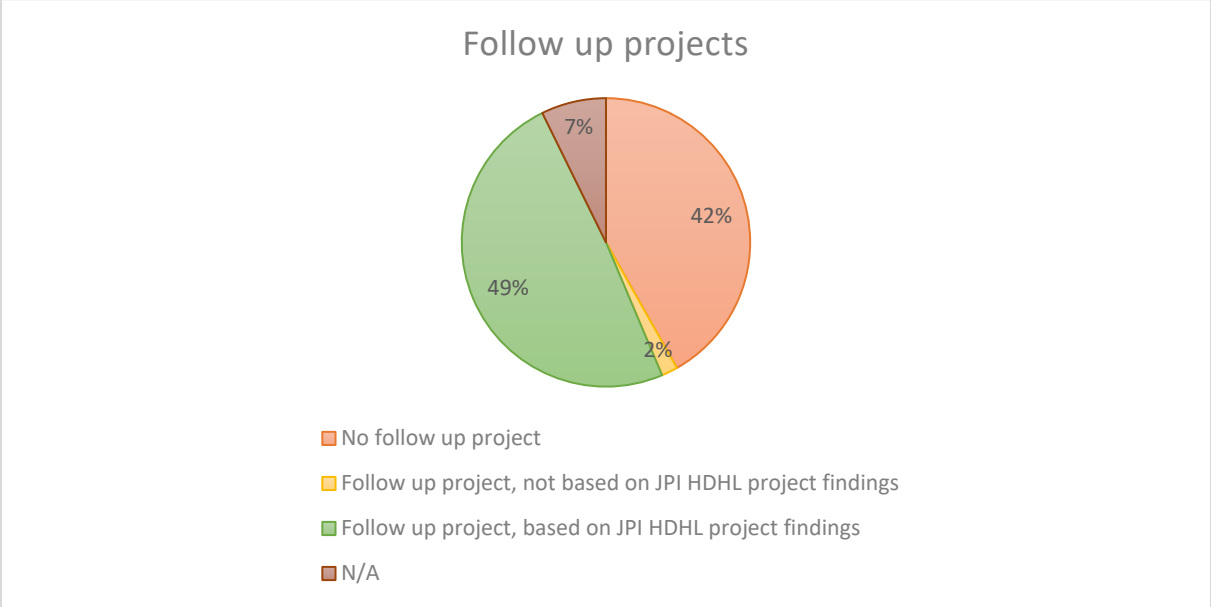

Figure 10: Bar chart showing how many survey respondents started a follow-up project using data from a JPI HDHL-funded project (in %).

Difference between knowledge hubs and traditional calls

The interview results show that knowledge hub projects used a broader range of knowledge products to present their results compared to traditional calls. Moreover, knowledge hubs utilised a greater number of dissemination routes per project. During the interviews, project coordinators from knowledge hubs highlighted that managing these types of projects presented more challenges due to the larger number of partners and stakeholders involved, in contrast to traditional calls. However, they also produced more concrete and visible outcomes. For instance, knowledge hubs frequently opted to

publish all their knowledge products on project websites, providing a centralised location to showcase all project outcomes.

"This is a very nice website. All papers are already there. We have 46 papers now on our site and everyone can read and just communicate and discuss and ask if there is anything not clear. So we were trying to disseminate using these channels specifically." – Knowledge hub coordinator.

Moreover, knowledge hubs involved non-scientific European stakeholders from the beginning of the project, leading to more results dissemination to sectors beyond science.

"The final symposium that we organised in Brussels, we organised in Brussels. Not elsewhere, in Brussels, for good reasons. We wanted to have the stakeholders, the interest groups there. We wanted to be close to them, to have a low threshold for them to participate." – Knowledge hub coordinator.

For traditional call project coordinators, determining whether the target audience was using their knowledge products was more challenging since stakeholder collaboration from the start of their project was less common and therefore they received less feedback from their target audience. Furthermore, due to the smaller scale of traditional calls, these projects experienced more mixed results regarding dissemination. In some cases, these smaller projects did not have the resources, often funding or time, to disseminate their results as initially intended. Although, the COVID-19 pandemic significantly contributed to this issue, causing delays in the data collection and analysis periods. Both types of projects also employed early career scientists, which include master, PhD and postdoc students, to improve the dissemination of their results even further.

"We wanted to go very early with the diffusion and submission of abstracts in big congresses. So we really encourage the young people very early in the process. Just to make abstract submissions so that they are already in the process of publication and things like that. It was one of the work packages that was fully devoted to this type of objective." – Traditional call coordinator.

In addition to the interview results, a statistical analysis was conducted to test the relationship between project types and various variables. The results of these tests can be seen in Table 4. The resulting p-values from each test were above the significance level of 0.05, indicating that the difference between project types is not statistically significant for the tested variables.

Table 4: Statistical analysis comparing project types to different variables obtained through the survey questions.

Variable	Test statistic	Degrees of freedom	Fisher exact test p-value
Project type vs. knowledge products planning	1.70	3	0.770
Project type vs. dissemination route planning	2.86	3	0.549
Project type vs. knowledge product choice	2.86	3	0.549
Project type vs. knowledge product reach	5.56	4	0.210
Project type vs. knowledge product use	4.55	4	0.360
Project type vs. target audience experience	2.09	3	0.611
Project type vs. impact satisfaction	4.90	4	0.429
Project type vs. partner expertise	0.95	1	0.591
Project type vs. co-financing structure	9.08	5	0.094
Project type vs. JPI HDHL impact	3.73	4	0.421

Discussion

Study aim

This study aimed to determine whether the results and knowledge of completed JPI HDHL projects have impacted policy or uptake in practice. The second aim was to determine whether projects within JPI HDHL were being structured and conducted efficiently and effectively to ensure the highest level of impact. To determine this, project coordinators and other partners were interviewed and surveyed, providing insights on how the projects were structured, how the results were presented and disseminated and what the impact was of these results on the target audience, such as the scientific community, policymakers, healthcare professionals or the industry. The knowledge hubs and traditional call projects were also compared to assess how the difference in their structure affects the project's impact.

Interpretation of results

To effectively address the main research questions, it is crucial to address the sub-question first. The primary objective of the sub-question was to determine the responsible research practices and productive interactions used in the research projects and their impact on generating outcomes. It is important to note that the ZIAF was developed by ZonMw in 2019, and due to the COVID-19 pandemic, it has not seen extensive use yet. Indicators used in this framework have been developed from the ground up, without using pre-established frameworks as a frame of reference, and have been formulated according to the experience and interpretations of ZonMw. Therefore, validating this framework by consulting outside sources is challenging. The interpretation of the results for this sub-question is formulated by the researcher using experience and gained insights from this study.

While no in-depth impact assessments have been conducted for research projects from other Joint Programming Initiatives, a first analysis of the impact and performance of the JPI HDHL secretariat was performed in 2020. This assessment concluded that the secretariat and management board of the initiative have a clear vision of how research should be conducted, building trust between the organisation and research partners and laying the groundwork for productive and successful research projects[13]. The findings of this project impact assessment can substantiate these conclusions. The overall quality of research within this initiative is very high. The diverse range of partners within the consortia, often comprising of leading experts in their respective fields, facilitate the development of novel tools and methodologies that were only possible with such expertise. These tools or methodologies build upon pre-existing and well-established techniques by being more effective or efficient, adding to the relevance of JPI HDHL-funded projects. Furthermore, JPI HDHL requires project coordinators to submit comprehensive research proposals during the application phase, including project planning and funding details. For instance, all JPI HDHL-funded research institutes must secure funding through their respective national research funding agencies. Therefore, all partners had no issues obtaining funding, increasing the time and money they could spend on their research. An external study states that well-funded research achieves more impact since these projects have the financial

means to produce a more complete project, which can then be published in higher-ranking journals[38]. Partly due to the funding structure of this initiative, researchers did indeed produce well-rounded project articles which are published in high-impact journals. Furthermore, JPI HDHL requires all partners to submit detailed plans stating how the project results will be presented and disseminated. Thus, all projects receive enough funding and are planned out well, contributing to the high quality of research. In general, due to the high quality of the research and the projects being structured and conducted effectively, these projects achieve a high degree of short-term scientific impact, according to the ZIAF[29]. Meaning, the knowledge produced in these projects can be applied to new scientific research and sectors beyond science due to the high quality, reliability and relevance of the research.

The indicator that has the most influence on project impact and varies the most in terms of usage and outcomes among all projects included in this study is result dissemination. This finding is in line with results from other studies. With around 2 million health-related research studies being published annually, a lack of research evidence is not an issue, rather, how this knowledge is diffused to relevant stakeholders has a larger effect on the impact of this knowledge[39,40]. The current study found that smaller-scale projects involving, for instance, four or less partners utilise fewer dissemination channels compared to larger projects. Moreover, these smaller projects predominantly use traditional mediums such as academic journals and conferences for dissemination. This is primarily due to the limited amount of researchers working on the project compared to larger consortia, resulting in constrained time and resources allocated to result dissemination. Similarly, projects coordinated by early-career researchers, who are at an earlier phase of their careers, encounter challenges in disseminating findings to non-scientific sectors due to their limited networks. Because of their limited experience, these researchers have yet to establish the necessary connections to disseminate results to policymakers, the healthcare sector, or the industry. The COVID-19 pandemic further exacerbated this issue, as early-career scientists from all sectors struggled to reach sectors beyond science[41]. While many projects express an interest in disseminating to stakeholders beyond the scientific community, those that do not plan for such dissemination prior to the project start often face challenges regarding time, funding, or connections to reach the target audience. While projects that proactively plan to disseminate to sectors beyond science and involve stakeholders from the projects start see a higher degree of knowledge utilisation by these stakeholders. A study conducted by Elwy et al. (2022) found that by including stakeholders from the start of the project, researchers gain a better understanding of what different mediums are needed to communicate with these target groups. These stakeholders also gain a deeper understanding of the research itself, leading to higher research outcome adoption rates in many different sectors[42]. Furthermore, although not included in the ZIAF, follow-up projects emerge as a frequently utilised and valuable medium for disseminating results. Numerous researchers highlight the challenge of assessing whether other researchers are accessing or using their results, as they lack access to analytical data from project websites or academic journals. Therefore, incorporating their findings in follow-up projects is one of the most direct forms of knowledge utilisation. Furthermore, due to COVID-19-related delays, several researchers face time constraints in analysing all the obtained data from their JPI HDHL projects within the 3-year timeframe. Using unanalysed datasets from previous projects in new studies proves to be an efficient and effective approach to ensure the utilisation of this data.

Additionally, re-using data from previous studies also increases the visibility of the data to new researchers or fields[43]. Older scientific fields, such as biology and agricultural science, have seen an increase in data reuse rates over the last decades. Most of the data that is re-used from older projects comes in the form of self-citations, where researchers cite their own previously published work to validate findings from new studies[44]. This phenomenon was also observed in this study.

The two project types were compared to assess whether there is a difference in impact generation between traditional call and knowledge hub projects. It is important to reiterate the aims for both project types. Traditional call projects aim to generate new knowledge, predominantly utilised and peer-reviewed by the scientific community. In contrast, knowledge hubs aim to gather and implement existing knowledge in non-scientific sectors. Therefore, for knowledge hubs, result dissemination is an integral aspect of the project and is typically planned through work packages. This approach is necessary as disseminating to industry or policymakers requires different strategies than the scientific community. For instance, educating policymakers through courses and workshops proves more effective than relying solely on scientific publications, which often require time and expertise to comprehend fully[45]. On the other hand, disseminating results within the scientific community primarily involves academic journals and conference presentations, as researchers tend to prioritise attending conferences relevant to their specific scientific field[46]. This was also observed in this study. Traditional call projects use a smaller range of knowledge products and dissemination channels to present and disseminate findings than knowledge hubs. However, since nearly all projects in this study publish in high-impact journals and participate in internationally recognised scientific conferences, which mainly target the scientific community, these projects effectively utilise the most important means to disseminate their outcomes. One external study states that projects that consider the target audience's contextual factors and habits when producing and disseminating their results achieve a higher degree of knowledge utilisation within these groups[47]. Generally, projects from both types use suitable knowledge products and dissemination strategies to reach their target audiences. Nonetheless, some coordinators of traditional call projects express an interest in disseminating their results to non-scientific sectors. However, they do not account for this during project planning or do not know how to approach these stakeholders. A significant difference between the two project types lies in the knowledge of how the target audience utilises project results. Researchers involved in knowledge hub projects work closely with their stakeholders, thus receiving more input and feedback on the project outcomes. In contrast, traditional call projects only occasionally involve stakeholders outside of science, resulting in researchers having limited knowledge of how their findings are used.

Strengths & limitations

One notable advantage of this study is the sequential design of the methodology. Conducting the interviews first allowed the researcher to identify the most relevant indicators from the ZIAF for measuring impact, which were then given greater emphasis in the survey. Furthermore, this approach enabled the inclusion of unforeseen factors or indicators not originally part of the ZIAF but that were relevant for measuring knowledge utilisation, such as follow-up projects, which were incorporated into

the survey. Lastly, the sequential design facilitated the validation of interview outcomes and ensured the involvement of all research partners, not solely the coordinators. Another strength of this study is the high project participation rate. Out of 45 eligible projects, 14 project coordinators were interviewed, and 28 projects participated in the survey, accounting for approximately one-third of the projects in the interviews and two-thirds in the survey. However, the overall response rate for the survey was low, with only 55 responses. Since the email addresses of all project researchers were unavailable, this study relied on the coordinators to forward the survey to all researchers, which only occurred for some invited projects. Consequently, only a small number of the approximately 900 eligible researchers completed the survey, resulting in small sample size and statistically insignificant outcomes. It is suspected that the differences between project types in the statistical analysis would have been more pronounced with a larger sample size. Additionally, 20% of survey responses originated from researchers from the same knowledge hub project, skewing the survey results. Furthermore, this study successfully established the short-term scientific impact of JPI HDHL projects. However, determining the long-term societal impact of this research was not possible since most of the projects included in this study concluded between 7 and 2 years ago. Research outcomes typically require an average of 17 years to become visible in real-world settings, making it challenging to assess the real-world implications of this research[17]. Furthermore, it is essential to note that this study only evaluates impact from the perspectives and outcomes reported by the researchers themselves. The inclusion of perspectives from the target audience regarding their experiences and utilisation of these research outcomes falls beyond the scope of this study. Lastly, including the ZIAF, the JPI HDHL impact assessment indicators mentioned in Table 2 and unforeseen indicators mentioned by project coordinators during the interviews led to a well-rounded impact assessment, which included a wide variety of indicators and factors that helped establish the impact of these projects. While the ZIAF proved to be a suitable framework for measuring short-term impact due to its relevant indicators, it lacks indicators that aim to assess the perspectives and experiences of the target audience. Other frameworks, such as the Canadian Academy of Health Sciences Framework mentioned by Greenhalgh et al. (2016) and the Research Impact Framework utilised by Kuruvilla et al. (2006), which both focus on assessing research impact, include indicators that revolve around communication with relevant partners and stakeholders[48,49]. Understanding how the target audience utilises project results and why the project outputs are or are not applicable in their respective fields would enhance the overall degree of knowledge utilisation by these stakeholders[48,49].

Recommendations

As mentioned earlier, some project coordinators expressed interest in disseminating their results to sectors beyond science. However, they experienced challenges due to their limited networks or the lack of consideration during project planning. To effectively communicate results to external sectors, it is crucial to utilise a transdisciplinary approach by involving these stakeholders from the start of the project[47]. Involving these parties enables a greater understanding of the science behind the project, thereby increasing the likelihood of implementing these results. Additionally, these stakeholders can express their preferences on how these results are presented to them, as academic publications may not always be suitable for this audience[47]. Furthermore, JPI HDHL could support projects with smaller

networks even more by facilitating connections between these researchers and individuals working in policymaking, the healthcare sector, or industry. This support would increase the chances of these results being used outside of science. As mentioned in the previous section, this study exclusively measures the short-term scientific impact of JPI HDHL projects. To establish the long-term societal impact of this initiative, a follow-up study should be conducted approximately 10 to 20 years after project completion, measuring how these research outputs translated into policy changes and how these policies affected society. Additionally, this study should include indicators that assess the experience of the target demographic in utilising this knowledge to determine its suitability for real-world application. Case studies, bibliometric analyses, or social media analyses could be included in the methodology to achieve complete and meaningful results[50]. I would like to direct my last recommendation to ZonMw. Despite the fact that the ZIAF was developed recently and did not see extensive use, it proved to be a suitable framework to measure short-term scientific impact. However, some new indicators could be introduced in a next iteration of the ZIAF to further optimise the framework. For instance, an indicator measuring the degree of data re-use in follow-up projects could be integrated to assess that aspect of knowledge utilisation. Additionally, an indicator that evaluates the communication between researchers and other stakeholders, such as in the Canadian Academy of Health Sciences Framework and the Research Impact Framework mentioned earlier, could provide insights on how the target audience experiences using the produced research outputs.

Conclusion

This study aimed to determine what impact JPI HDHL projects generated in the field of nutrition in relation to the research program structure and management. Overall, JPI HDHL-funded projects achieve a high degree of short-term scientific impact due to the high quality of research, unique consortia with specialised knowledge, varied amount of mediums used to present and disseminate project results and good project planning and management. Both project types are structured and conducted in a way that produce meaningful outcomes, which can be applied to the specific sectors they target. Future studies could include stakeholders beyond science from the start of the project to disseminate to these sectors even further.

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Appendix

Appendix 1: Project timetable

	March	April				May				June			
	Week 8	Week 9	Week 10	Week 11	Week 12	Week 13	Week 14	Week 15	Week 16	Week 17	Week 18	Week 19	Week 20
Interviewees recruitment													
Data collection interview													
Data analysis interview													
Developing survey													
Data collection survey													
Data analysis survey													
Complete analysis													
Draft results													
Writing -results													
Writing - discussion + conclusion													
(re)writing all chapters													
Process feedback													
Finalize and submit report													
Preparing presentation													
Submitting report													

Appendix 2: Interview guide

This appendix contains the interview guide used to interview all project coordinators.

Welcome [*title* + *name interviewee*],

Pleased to meet you, my name is Christian Moog. I am a Global Health Research student at the Vrije Universiteit in Amsterdam and for my master internship I am working at JPI HDHL at ZonMw in the Netherlands. For my internship project I will write an impact assessment of 10 completed projects that were funded by JPI HDHL. The goal is to establish what sort of societal and/or scientific impact these projects have created in the field of nutritional research. With impact I mostly intend knowledge utilisation. So I would like to know what is being done with the produced knowledge from these studies, examples could be the application of the results in new scientific research or for example in policymaking.

So to measure the impact of these projects I will interview project coordinators and ask questions about how the projects were structured and what was done during the planning, monitoring and evaluation phases to ensure that the produced results will be applied in practice.

Before we start the interview I would like to thank you for your participation in this project. I sent you an informed consent form via email prior to this interview. You returned the signed document, thank you for that. As you could read in the form it is important to state that the interview can be interrupted or terminated at any time. The interview will be recorded, however the recording will be deleted as soon as the recording has been transcribed. Do you have any questions about the form? In case you have any questions during the interview, please let me know as well. I will now start the interview by pressing record (*press record*).

During this interview I would like to discuss some aspects regarding your project. But I would first like to start with and introduction and some general questions regarding your project.

<u>General questions</u>

- Could you briefly give me an introduction on who you are and what your connection is/was to JPI HDHL?
- Could you briefly introduce the project you coordinated? (goals and methods)

<u>Collaboration with relevant partners</u>
The next questions revolve around all the partners and stakeholders that participated in this project.

- With whom was there (the most) collaboration at project level?
- To which category or field does this partner belong?
- What was the importance of the partner(s) to the project?
- Describe how the collaboration(s) progressed throughout project planning, monitoring and evaluation?

<u>Delivery of usable knowledge products</u>

- What knowledge products have been delivered at project level?
- For which target group(s) is the product intended?
- During which step of project planning, monitoring and evaluation did you decide which knowledge product would fit the goal/this project best?
    - Did your ideas regarding these products and target groups change at all during the duration of the project, and why?

- Is the product being used?
    - Who/which stakeholder(s) is/are using it?
    - What is the stakeholder experience of using the product?

Targeted dissemination and implementation activities

- What implementation strategies and activities have been deployed?
- During which stages of project planning, monitoring and evaluation were implementation strategies deployed?
    - Did these strategies change or evolve over time? If yes, how and why?
- What dissemination route worked the best at disseminating the outcomes for this specific project, and why?

Innovation of methodology

- In what way was methodological innovation achieved in this project?

Transparency and replicability of the study

- In what way was transparency/openness of research achieved in your project?
- In what way was replicability of your research achieved in your project?

Co-financing

The collaborating countries all participated to the financing

- Who contributed which resources at programme level?
- What was the added value/What did the co-financing add to this study?

Ending questions

- What part or aspect of your project would you change in retrospect when it comes to the impact your project created?
- What could be done from the side of JPI HDHL to increase the amount of impact affiliated research projects have in the field of nutritional science?
- What is the added value of initiatives such as JPI HDHL when compared to coordinating a research project that is not affiliated with a such an initiative?

Conclusion

We arrived at the end of this interview, thank you very much for your time and insights!

- Would you like to add anything to our discussion?
- Or do you have any questions or comments regarding this interview?

In the upcoming weeks/months I will also make a survey that will include some of the topics discussed in this interview and that will be sent to all project coordinators of JPI HDHL funded projects. By then I would like to ask you to fill in the survey as well and to send the survey to all project members involved in the project.

Thank you again for your time and I wish you a pleasant day!

Appendix 3: Interview consent form

Interview April & May 2023

Research project title: *Changing nutrition: assessing the impact of JPI HDHL*

The interview will take 60 minutes. We don't anticipate that there are any risks associated with your participation, but you have the right to stop the interview or withdraw from the research at any time.

Thank you for agreeing to be interviewed as part of this research project. This consent form is necessary for us to ensure that you understand the purpose of your involvement and that you agree to the conditions of your participation. Would you therefore read the information stated below and then sign this form to certify that you approve the following:

- The interview will be recorded and a transcript will be produced.
- You will be sent the transcript and given the opportunity to correct any factual errors.
- The transcript of the interview will be analysed by Christian Moog as research investigator.
- Access to the interview transcript will be limited to Christian Moog and academic colleagues and researchers with whom he might collaborate as part of the research process.
- Any summary interview content, or direct quotations from the interview, that are made available through any outlet will be anonymized so that you cannot be identified, and care will be taken to ensure that other information in the interview that could identify yourself is not revealed. In the case that a statement or quote needs to be linked to the specific project you coordinated, due to contextual reasons, specific consent will be asked.
- The actual recording will be destroyed once the transcript has been completed and approved.
- Any variation of the conditions above will only occur with your further explicit approval.

By signing this form I agree that;

1. I am voluntarily taking part in this project. I understand that I don't have to take part, and I can stop the interview at any time.
2. The transcribed interview or extracts from it may be used as described above.
3. I have read the information listed above.
4. I don't expect to receive any benefit or payment for my participation.
5. I can request a copy of the transcript of my interview and may make edits I feel necessary to ensure the effectiveness of any agreement made about confidentiality.
6. I have been able to ask any questions I might have, and I understand that I am free to contact the researcher with any questions I may have in the future.

Date:

_____

Participant name: Participant signature:

_____ _____

Appendix 4: Survey

It has been 7 years since the first JPI HDHL funded project ended. Since then, over 80 scientific projects were completed or are still ongoing. The rapid growth of the initiative lead to numerous promising scientific results, but are these results being applied in practice? Recently, JPI HDHL started and internal study with the goal to assess the societal and scientific impact of projects that were funded via the initiative. The outcomes of this study will be used by JPI HDHL to assess the relevance of these projects in the field of nutritional science and to determine the future direction of the initiative.

On behalf of JPI HDHL, I kindly invite all researchers involved in projects that are funded via JPI HDHL to fill out this survey, enabling us to learn more about the impact your projects create. Completing the survey will take no longer than 5 minutes. Since we do not have access to the contact details of all involved researchers, I would kindly ask all project coordinators to forward the survey to all involved researchers/partners.

1.What is the name of the research project you are/where involved in?

Text answer

2.What is/was your position in this research project?
Coordinator
Researcher
Other

3.Is your project currently active, or has it been completed?
Currently active
Completed

4.Since project completion, did a follow up project start based on the outcomes of the previous project? *Answer "N/A" if the project is currently active.*
No follow up project
Follow up project, not based on previous JPI HDHL project/findings
Follow up project, based on previous JPI HDHL project/findings
N/A

5.What knowledge products (examples mentioned below) have been/will be delivered after project completion? (multiple answers possible)
Article in scientific journal
Article for a broader readership
Digital application (App)
Website
Video content
Intervention
Book
Newsletter/News report
Protocol/Guideline
Lecture/Educational course
Toolbox
Other

6.Which knowledge product created the most interaction/reached the biggest audience?
Article in a scientific journal
Article for a broader readership
Digital application (App)

Website
Video content
Intervention
Book
Newsletter/News report
Protocol/Guideline
Lecture/Educational course
Toolbox
Other

7.Which medium was used/will be used to share the products? (multiple answers possible)
Academic journal
Non-academic journal/magazine/book
Course/workshop
Conference
Software
Website
Database
Peer-to-peer communication (coaching/consulting/meeting)
Social media
Other

8.Which medium worked the best at disseminating the knowledge product?.
Academic journal
Non-academic journal/magazine/book
Course/workshop
Conference
Software
Website
Database
Peer-to-peer communication (coaching/consulting/meeting)
Social media
Other

9.Did the knowledge product(s) and/or dissemination medium change during the duration of the project? *If yes, please specify why and how.*

Text answer

10.For which target group(s) is the product intended? (multiple answers possible)
Scientific community
Healthcare sector (workers/patients)
General public
Policymakers
Industry
Other

11.During project planning it was clear which knowledge products would be delivered.

Strongly disagree-Disagree-Don’t know-Agree-Strongly agree-N/A

12.During project planning it was clear how knowledge products would be disseminated.

Strongly disagree-Disagree-Don’t know-Agree-Strongly agree-N/A

13.The knowledge product(s) were chosen based on the needs/requirements of the intended target audience.

Strongly disagree-Disagree-Don't know-Agree-Strongly agree-N/A

14.The knowledge product(s) reached the intended target audience.

Strongly disagree-Disagree-Don't know-Agree-Strongly agree-N/A

15.The knowledge product is being/has been used by the intended target audience.

Strongly disagree-Disagree-Don't know-Agree-Strongly agree-N/A

16.What is the target audience experience of using the product?
Very negative-Negative-Don't know-Positive-Very positive-N/A

17.I am satisfied with the amount of impact my project created in its intended field.

Strongly disagree-Disagree-Don't know-Agree-Strongly agree-N/A

18.What could be done to further increase the impact of your project?

Text answer

19.Did the project create more impact in the field of nutritional science or health science?
Nutritional science
Health science
Both equally

20.Which type of partners/stakeholders directly participated in your project? (multiple answers possible)
Research institutes
Universities
Practice (e.g. Hospitals, Care facilities)
Non-governmental organisations
Governmental institutions (e.g. Ministries)
Funding agencies
Industry
Insurance companies
Other

21.Partners from how many different countries directly participated in the project?
1
2
3
4
5
6
7+

22.The participation of international partners was of added value to the project.

Strongly disagree-Disagree-Don't know-Agree-Strongly agree-N/A

23.The participating partners provided unique expertise or skills that were needed to complete the project.
Strongly disagree-Disagree-Don't know-Agree-Strongly agree-N/A

24.Did the programme involve compulsory or desirable co-financing (in cash or in kind)?
In cash
In kind
Both in cash and in kind
Neither in cash or in kind
Other

25.The compulsory or desirable co-financing structure was of added value to the project.
Strongly disagree-Disagree-Don't know-Agree-Strongly agree-N/A

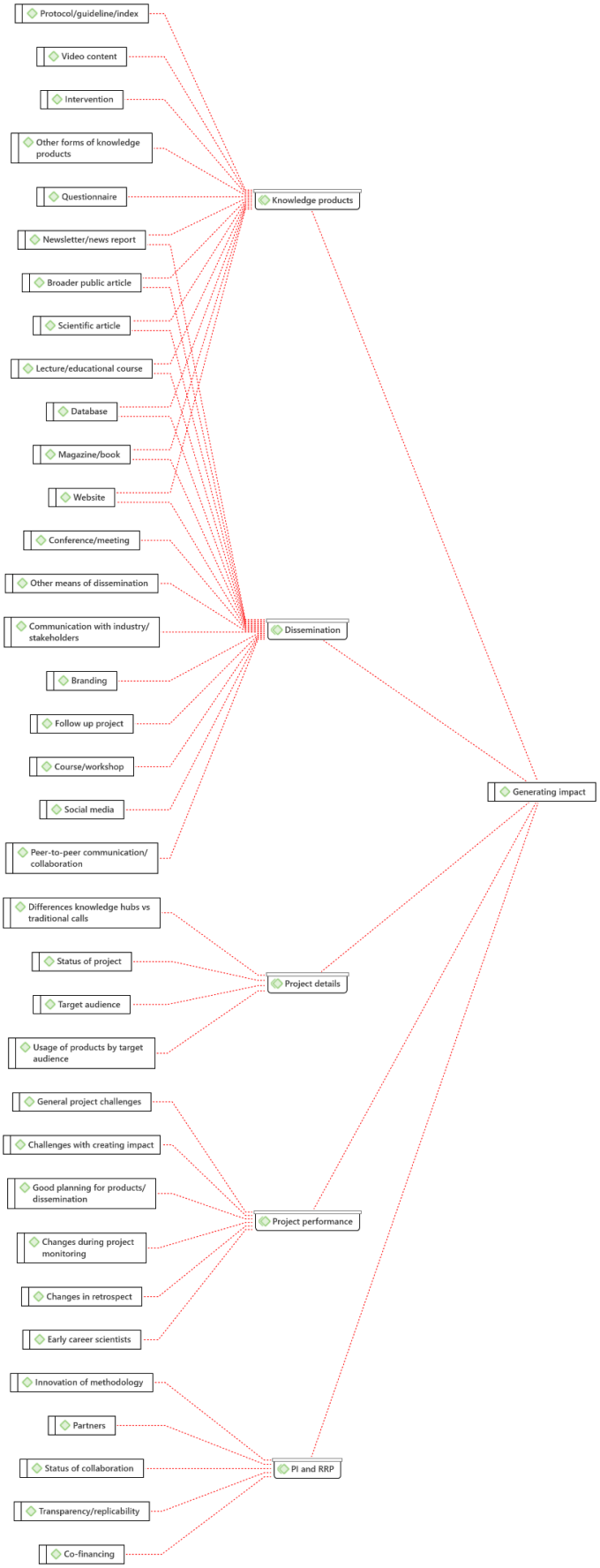
26.Participating in an initiative such as JPI HDHL increases the amount of impact a research project has when compared to projects without such an affiliation.
Strongly disagree-Disagree-Don't know-Agree-Strongly agree-N/A

27.What could be done from the side of JPI HDHL to further increase the impact of projects that are funded via the initiative?
Text answer

28.What could be done from the side of JPI HDHL to further support the projects that are funded via the initiative?
Text answer

29.Concluding remarks.
Text answer

Appendix 5: ATLAS.ti code tree



Appendix 6: Data management plan

This data management plan was written using the DMP online tool provided by the Vrije Universiteit Amsterdam.

1. General features of the project and data collection

1.1 Project leader contact details

1.2 In collecting data for my project, I will do the following:

Generate new data: All data used in this study will be generated by the student.

1.3 In my research, I will use:

A combination of quantitative and qualitative data: In this study qualitative data will be collected by performing interviews, while a survey will be used to collect quantitative data.

1.5 I will be reusing or combining existing data, and I have the owner's permission for that.

No, I will not be reusing or combining existing data

1.7 I am a member of a consortium of 2 or more partners. Clear arrangements have been made regarding data management and intellectual property. (also consider the possible effect of changes within the consortium on issues of data management and intellectual property)

No, I am not working with 2 or more partners

1.8 I can give an estimate of the size of the data collection; specifically, the number of participants or subjects (“n=”) in the collection and its size in GB/TB

Yes (please specify): 16 interviews that are one hour long will be transcribed, the recordings will be destroyed after transcription. In total, the file size of the transcriptions is under one GB. Additionally, 100 people of interest will receive the survey. If everybody responds the survey file size will be around two GB. In total, I expect the collected data to be under 5 GB in size.

1.9 The following end products I will make available for further research and verification (please elaborate briefly)

Documentation of the research process, including documentation of all participants
Raw data
(Several versions of) processed data

The raw transcription and survey data will be stored in addition to the processed data. Furthermore, the analyzed data will be included in a project document, describing how the data was collected, analyzed and stored.

1.10 During the project, I will have access to sufficient storage capacity and sites, and a backup of my data will be available. (please elaborate briefly)

Yes, I will make use of my institution's standard facilities for storage and backup of my data

2. Legislation (including privacy)

2.1 I will be doing research involving human subjects, and I am aware of and compliant with laws and regulations concerning privacy sensitive data.

Yes, I will involve human subjects in my research. I will comply with the Algemene Verordening Gegevensbescherming (AVG)

2.2 I will be doing research involving human subjects, and I have (a form of) informed consent from the participants for collecting their data.

Yes (please describe the form this consent takes): All participants, including interviewees and people participating in the survey, will provide their informed consent. Interviewees will need to fill in a written informed consent form before participating in the interviews. People filling in the survey will need to tick a box, agreeing to the data collection and analysis processes.

2.3 I will be doing research involving human subjects, and I will protect my data against misuse.

Yes, the data will be pseudonymised. (please explain how this will be done, and by which organisation) and individuals participating in this project are all project coordinators and board members from the same organisation that issues this study. Therefore, it is not possible or needed to fully anonymize the participants, since these individuals are already known, and work for/have worked for, this organization.

2.4 I will stick to the privacy regulations of my organisation

Yes

3. Making data findable

3.1 The data collection of my project will be findable for subsequent research. E.g., on a catalogue, a web portal, or through the search enginge of the repository (note: this is **key item 3**, which you should report to ZonMw at the end of your project).

Yes, it can be found through the search engine of the archive or repository in which it is stored (please specify). The data will be stored on the internal company server of ZonMw, allowing individuals with the appropriate accessing rights to access all documents from this project. Additionally, data will be stored on the online platform SURFdrive provided by the Vrije Universiteit.

3.2 I will use a metadata scheme for the description of my data collection (note: this is **key item 7**, which you should report to ZonMw at the end of your project).

No, I have not yet chosen a metadata scheme

3.3 I will be using a persistent identifier as a permanent link to my data collection (note: this is **key item 1,** which you should report to ZonMw at the end of your project).

Yes, I will be using the DOI code

4. Making data accessible

4.1 Once the project has ended, my data will be accessible for further research and verification.

Yes, immediately

4.2 Once the project has ended, my data collection will be publicly accessible, without any restrictions (open access).

No, there will be access restrictions to my data collection (please explain). Only employees from ZonMw and JPI HDHL will have access to produced data. It is not yet decided whether the results of this study will be publicly published.

4.3 I have a set of terms of use available to me, which I will use to define the requirements of access to my data collection once the project has ended (please provide a link or persistent identifier; also note that this is a **key item 4**, which you should report to ZonMw at the conclusion of your project).

Not yet, my institution will draft a set of terms of use with the help of a legal advisor

5. Making data interoperable

5.1 I will select a data format, which will allow other researchers and their computers (machine actionable) to read my data collection (note: this is **key item 5**, which you should report to ZonMw at the end of your project).
Yes (please specify)
The interview recordings will be stored in an .mp3 format.
The transcriptions will be stored as .txt files.
The outcomes of the survey will be stored as a .csv file.
The statistical data will be stored in the native R file format.

5.3 I will be doing research involving human subjects, and I have taken into account the reuse of data and the potential combination with other data sets when taking privacy protection measurements.

Yes, the participants have given their permission for reuse of the data, and the data have been pseudonymised

6. Making data reusable

6.1 I will ensure that the data and their documentation will be of sufficient quality to allow other researchers to interpret and reuse them (in a replication package).

I will perform quality checks on the data to ensure that they are complete, correct and consistent (please explain)
After transcription, the .txt files will be checked again by re-listening the recordings to ensure that everything in the transcription is factually accurate. All of the files will also receive file names that adhere to the chosen format.
Before statistical analysis the survey results .csv document will be checked as well, making sure no data is missing.

6.2 I have a number of selection criteria, which will allow me to determine which part of the data should be preserved once the project has ended. (see also question 1.9 and 6.1)

Yes. Only the interview recordings will be destroyed, the interview transcriptions and raw survey results, including the processed R and ATLAS.ti files, will be preserved.

6.3 Once the project has ended and the data have been selected, I can make an estimate of the size of the data collection (in GB/TB) to be preserved for long-term storage or archival.

Yes (please specify). As stated above, I expect the collected data files to be under 5GB in size. The R and ATLAS.ti files from the processed data will be under 5GB as well, resulting in a total file size under 10GB.

6.4 I will select an archive or repository for (certified) long-term archiving of my data collection once the project has ended. (note: this is a key item, which you should report to ZonMw at the conclusion of your project)

Yes, and this archive has a data seal of approval (please specify the archive). All of the data will be stored on the ZonMw company data drive, which meets certain data storage criteria.