

Summary of SRA EpiHealth (LU part) activities during 2014-2019

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Introduction

The Strategic Research Area *Epidemiology for Health* **SRA EpiHealth** (<https://www.epihealth.lu.se/>) has been active since 2010 and consists of a research network for excellence linking the Lund and Uppsala Universities (LU and UU). SRA EpiHealth is funded by the Research Council (“Vetenskapsrådet”) of Sweden with the aim to promote national and international excellence in epidemiology. The SRA has a leadership structure with a Steering Committee involving representatives from both universities, as well as an Executive Board. The annual funding is about 10.5 million SEK and divided between the Lund and Uppsala Universities (60/40 percent). We have three main areas of research activity: (a) *Basic Epidemiology* (genetics, epigenetics, gene-environmental interactions for disease prediction), (b) *Infrastructures* (cohorts, biobanks, experts in biostatistics, bioinformatics and advanced epidemiology), and (c) *Clinical Epidemiology* (patient registers, health economics, disease prognosis, survey of infectious disease epidemiology). In addition to this we promote educational activities at different levels, from undergraduates to post-docs and a course in “*Advanced Epidemiology*” every year, alternating between LU and UU. We build infrastructures such as staff and a new cohort (EpiHealth-Elderly) with 24 000 screened subjects (age range 45-75 years) for extensive analyses of health and disease risk, linking to national registers on morbidity and mortality. During the period the number of members of our SRA has been about 200.

The SRA EpiHealth has stated the following major research questions:

- How do genes interact with the environment for risk of disease?
- What links dietary intake, gut microbiota and organ function?
- How does early life factors influence adult health?
- Why do patients with the same disease have different prognosis?
- How could health economics and social epidemiology inform clinical decision making?

A. SWOT analysis

Strengths

The very successful SRA EpiHealth is active at both the Lund and Uppsala Universities, but led by the Lund University. Peter M Nilsson has been the Director of SRA EpiHealth during the period 2010 to 2019 appointed by the Lund University Vice Chancellor. In the SRA EpiHealth network more than 200 scholars from the two universities have worked since the start in 2010 with an annual total output of about 800 scientific papers. This is a sign of scientific strength. We have a number of very productive researchers in SRA EpiHealth at Lund University, for example in the following research groups of *Internal medicine - Epidemiology* (Head: Peter M Nilsson, web of science H-index 2014-2019 and total: 36/97), *Cardiovascular research-Hypertension* (Head: Olle Melander: H-index 45/96), *Cancer Epidemiology* (Head: Håkan Olsson: H-index 30/91), *Diabetes - Cardiovascular Disease* (Head: Marju Orho-Melander, H-index: 28/61), *Geriatrics* (Head: Sölve Elmståhl; H-index 12/36), *Cardiovascular Epidemiology* (Head: Gunnar Engström, H-index 26/60), *Applied Epidemiology and Methods*, EPI@LUND (Head: Jonas Björk, H-index 17/40, and Anna Rignell-Hydbom, H-index 7/25), *Health Economics* (Head: Ulf Gerdtham: H-index 11/37); *Environmental epidemiology* (Head: Lars Rylander: H-index 15/46; member Karin Källén: H-index 18/40); *Family Medicine and Clinical Epidemiology* (Head: Jan Sundquist 2010-2018: H-index 24/56, and Head: Kristina Sundquist 2018- :

H-index 23/50), *Genetic and Molecular Epidemiology* (Head: Paul Franks: H-index 43/72), *Clinical Epidemiology Unit/Musculoskeletal Epidemiology* (Head: Martin Englund: H-index 16/46; Head of Research at Skane University Hospital, SUS: Ingemar Petersson: H-index 17/41), and *Social Epidemiology* (Head: Juan Merlo, H-index 13/42) to name some of them. In addition, the researchers listed in SRA EpiHealth are dedicated to increase our cross-discipline research projects for the future, and have also attracted substantial funding, about 105 million SEK annually during 2014-2018. A fundamental strength is the access to large-scale population-based cohorts with biobanks (for example the *Malmö Preventive Project* (n= 33,000), *Malmö Diet Cancer* (n= 30,000) and *Malmö Offspring Study* (n= 4300), SCAPIS (n= 6000), “*Gott Åldrande i Skåne*” (GÅS; n= 4000), and the *EpiHealth-Elderly* cohort (n= 11,000 in Malmö), the *MISS cohort* (n= 29,508 women representing 74% attending) coming for mammography and with salivary DNA samples, as well as the “*Lund University Population Research Platform*” (LUPOP; www.lupop.lu.se) initiative for collecting, storing and structuring cohort information at the Lund University from all over the Scania region. In social epidemiology a number of international guest researchers have been active and still are. At the Uppsala University a corresponding number of research groups are very active based on local and national cohorts, as well as patient registers at the Uppsala Clinical Research Centre (UCR).

Weaknesses

It must be recognized that we represent a very heterogeneous field of research and that the constant support of cohorts, registers and biobanks means a heavy workload as well as substantial investment of funding and staff. We would also need further support for developing infrastructures, new academic positions (tenure track), as well as attracting young researchers both with and without a medical professional training background. In addition we need to promote translational research based on our genetic studies applying Mendelian randomization analyses, both involving the clinical sector and basic science where lab animal models can be used to further study disease mechanisms as potential drug targets.

Opportunities

As the need for epidemiological evidence and health statistics is increasing, both for academic and societal purposes, there exists an opportunity to expand our research strategy based on cohorts, biobanks and register linkages with local, regional and national registers. Access to big data, in combination with novel machine learning algorithms and solid epidemiologic reasoning, opens up vast new possibilities in medicine and public health research. Furthermore, as epidemiology attracts many researchers irrespective of gender and social or ethnical background, we possess a great opportunity to find good collaborations both within Sweden and on the international arena. Such collaborations should include joint projects with experimental researchers as well as international joint projects for validation and replication of our findings.

Threats

Of considerable importance is to overcome threats posed by lack of funding or skilled staff, for example in biostatistics and bioinformatics, as well as complex algorithms. Furthermore, we need to tackle new legislative limitations to carry out population-based research with broad aims, as is imposed on us by European legislation (GDPR) that also Swedish authorities have to comply with. Lack of funding as a reflection of fierce competition could lead to hesitance to employ young people in the research teams, especially as new rules of the Faculty of Medicine in Lund state that clinical PhD students must be offered at least half-time research opportunities over several years to be accepted as PhD students. This is difficult not only from the long-term funding perspective, but also because the everyday hospital care routines will not always allow to accommodate that clinical PhD students leave their patients or clinical duties if there is a lack of staff, as is often the case.

For a more detailed SWOT analyses of SRA EpiHealth, see **Appendix** (page 12-15).

Important events and achievements at SRA EpiHealth (LU) during the period 2014 – 2019

SRA EpiHealth has organized both an extensive new cohort with 24,000 screened subjects in Uppsala and Malmö (EpiHealth-Elderly Cohort). In addition, our researchers have been able to set up new population-based cohort studies during the period, for example the *Malmö Offspring Study (MOS)* with so far 4300 participants (<https://snd.gu.se/sv/catalogue/study/ext0202>), the *SCAPIS Malmö study* (<http://scapis.se/malmo/>; n= 6251) and the *LUPOP infrastructure* with at present more than 50 cohorts in Scania made visible (<https://www.lupop.lu.se/lu-cohorts/>). Some of our most notable publications are using these cohorts and have appeared in prestigious journals such as New England Journal of Medicine, Nature, Nature Genetics, Science, Circulation, the Lancet, Diabetologia and Diabetes Care. Four patents have been filed in the field of cancer epidemiology (H Olsson). The funding obtained includes grants from the Swedish Research Council (VR) to many of our listed researchers, including **ERC grants** (as PI to Håkan Olsson, Marju Orho-Melander, Paul Franks, Olle Melander, Jan Sundquist, and Martin Englund) and large **NIH grants** (to Jan Sundquist, Kristina Sundquist, and Paul Franks). We have arranged a series of high-ranking symposia and conferences with participation of many of our researchers, dedicated for example to early life programming, diabetes and the heart, or biomarker discoveries. A few of these symposia have been based on a collaboration with the Swedish Society of Medicine, so called Berzelius symposia. Researchers from SRA EpiHealth (Anna Rignell-Hydbom, Jonas Björk) have through repeated funding from VR during the last ten years (including 2014 – 2018) coordinated the research and educational activities within SIMSAM Lund, which has been part of the national SIMSAM-network (www.simsam.nu) for register-based research in the medical and social sciences. A major outreach activity of SIMSAM Lund was NordicEpi Lund 2017, the 8th Nordic Meeting in Epidemiology and Register-Based Research in Lund 2017 (<https://mkon.nu/nordicepi>), with about 175 participating researchers from the Nordic countries.

Benchmarking in relation to Swedish and international research institutions

Internationally we bench-mark in relation to the Harvard Department of Epidemiology, School of Public Health, Harvard, Boston, USA, and also the “Multi-Ethnic Study of Atherosclerosis” (MESA) study for advanced epidemiological screening methods in an ethnically diverse population in the US. In Sweden, we have over the years developed very fruitful contacts with the Uppsala Clinical Research Centre, UCR (<https://www.ucr.uu.se/sv/>), where epidemiology is advanced based on cohorts and quality registers, for example SWEDHEART for patients with established ischemic heart disease and related events.

Organization of SRA EpiHealth leadership

Our SRA EpiHealth is organized with a *Steering Committee* and a smaller *Executive Board*, for names see web-site (<https://www.epihealth.lu.se/kontakt>). In practice our SRA involves several independent research groups in Lund, Malmö and Uppsala. Goals for research are set within each research group, but we collaborate for a joint research strategy within SRA EpiHealth as well as within the different cohorts and infrastructures that we are responsible for. A new research plan is under development for 2020-2025, but our present research plan is visible at our web-site: <https://www.epihealth.lu.se/>

Resources are allocated based on funding from the Faculty of Medicine, but most importantly based on national and international funding, i.e. from the Swedish Research Council and other funding agencies such as The Heart- and Lung Foundation, FORTE, FORMAS, and VINNOVA, as well as ERC; NIH and other international institutions.

The use of funding from the Research Council and from other external sources

We have used this funding for salaries and support of permanent staff involved in research and teaching. External funding is used for funding of research projects, building of infrastructures (cohorts, registers, biobanks) and analyzing GWAS and biomarkers in the EpiHealth-Elderly cohort, but also to

recruit and employ young researchers for various time periods. As in the past we want to apply and also be granted large international funding from the European Research Council (ERC) and the National Institute of Health (NIH), USA.

Recruitment, promotion and succession

According to the rules of the Faculty of Medicine we have to safeguard financial support for new PhD students and other research students, but also to support young post-docs to become more independent and to apply for their own funding. Succession of research leaders is a long-term process and we have only limited funding to employ new staff, a process that must be linked to the Faculty of Medicine. The SRA EpiHealth has taken several initiatives to recruit and support new staff for various durations.

Publication patterns

We have a very large size (volume) of excellent publications and make priority for publications in high-ranking and medium-ranking journals, preferably with Open Access according to the recommendations by the Swedish Research Council. These journals are mostly found in the medical field, but occasionally we also publish in more general scientific journals with Nature as a noticeable example. The Third Task of the Lund University obliges us to disseminate research findings also to the non-academic world via traditional and social media, seminars, and other outreaching activities.

Our overarching research strategy

In SRA EpiHealth we have a general research strategic plan ever since 2010 but also for the current period (2017-2019), to be found at our SRA EpiHealth web site (<https://www.epihealth.lu.se/om-oss>). We try to balance research with educational efforts as we have initiated many educational activities in Epidemiology (Björk, Engström, Merlo), both within SRA EpiHealth, at Lund University and in national collaborations. A new strategic plan for the period 2020-2025 is currently being developed in dialogue with the Lund University leadership, for which Professor Sölve Elmståhl is responsible, the new Director elect for SRA EpiHealth from 2020 onwards.

B2. Collegial culture

a. Opportunities for junior scholars to develop their originality and independence

We often advise junior researchers to present their ideas at seminars and attend courses, some offered by SRA EpiHealth, and many organized by the Jonas Björk and co-workers, and by LUPOP. Also Juan Merlo has organized courses in “*Advanced epidemiology*” for SRA EpiHealth, and Martin Englund has held 2-day seminars for PhD’s and postdocs in Musculoskeletal Sciences. In addition junior scholars are encouraged to present their work at PhD conferences within the FORTE EpiDem-network (www.lupop.lu.se/epidem), international conferences and attend PhD schools held nationally, (e.g. through the SIMSAM-network), or in neighboring countries. Over the years four courses have been held at Örenäs castle for PhD-students and their tutors as organized by Karin Källén and Gunnar Engström, involving Jonas Manjer for the first course.

b. Sustainability and renewal of research strengths

It is of great importance to support each other within and between the research groups, both on the project level and on the individual level. One useful consequence is that this could strengthen joint and interdisciplinary research applications for funding of broad projects. A renewal of research strengths comes with new recruitments or links with external researchers or networks sharing similar interests, for example the collaboration in arterial research between Malmö (Nilsson, Engström) with a similar group in Shanghai, China, and the collaboration between elderly cohorts in Sweden in the Swedish National study on Aging and Care, SNAC (Elmståhl). Of special importance is to further develop our

data-bases and strategic resources for sustainability of epidemiological research at excellence level. We also need to strengthen our contacts with clinical experts for investigating clinical applications of our research results.

c. Academic networks and collaborations outside your unit

We have developed a high number of such collaborations, both based on our many research groups, and based on the SRA EpiHealth. Here we list some, but not all, of the most prominent networks related to:

1. Research group **Internal medicine - Epidemiology**, and **SRA EpiHealth** work with Uppsala Clinical Research Centre (UCR), Uppsala University; Institutionen för Medicinsk epidemiologi och biostatistik (MEB), Karolinska Institutet; European Group on Insulin Resistance (<http://www.egir.org/>); and The Diabetes (InterAct) Working Group as part of The European Prospective Investigation into Cancer and Nutrition (EPIC). In rheumatology (as part of the research group) several collaborations exist, such as the EULAR Task Force on Sjögren's Syndrome.
2. The research group in **Cardiovascular Epidemiology** is involved with the national Swedish SCAPIS study (<http://scapis.se/>) for advanced imaging of pulmonary and cardiovascular structure and function. Important collaborations with Uppsala University and Sahlgrenska academy at Gothenburg University. In addition, international contacts exist with Chinese universities (Shanghai) for vascular research, and with EPIC-Heart and the network Emerging Risk Factor Collaboration (ERFC), led by researchers from Cambridge, UK. The research group participates in multiple international genetic consortia.
3. The research group **Applied Epidemiology and Methods (EPI@LUND)** has extensive contacts, among which are the following: National Bioinformatics Infrastructure Sweden (NBIS; <https://nbis.se/>), SIMSAM (www.simsam.nu), and FORTE EpiDem Network for register-based research (<https://www.lupop.lu.se/epidem>), Health Metrics at Sahlgrenska Academy, Centre for Economic Demography and CASE (Centre for Ageing and Supportive Environments), both at Lund university, Institute for Environmental Medicine at Karolinska institutet, European Kidney Function Consortium (EKFC), Neuropsychiatric Epidemiology Research Unit at University of Western Australia.
4. The research group in **Social Epidemiology** has developed a number of national and international project network contacts, among which are the following: for “*Multilevel analyses*” with Center for Multilevel Modelling, Bristol University, UK; Institute of Health Policy, Management and Evaluation, Toronto University, Canada; Department of Social and Behavioral Sciences, Harvard School of Public Health, USA. In addition in a project for “*Intimate partner violence*” with Valencia University, Spain; Department of Gender Studies, Lund University, and Department of Criminology, Malmö University. In addition, bilateral contacts have been developed with Department of Medical Epidemiology and Biostatistics (MEB) and Geriatric Pharmaco-epidemiology at Karolinska Institutet; Aarhus University Hospital, Denmark; Institute of Health Carlos III, Madrid, Spain; University of Oregon, USA; and Universidad de Las Palmas de Gran Canaria (ULPGC), Spain. Finally, Juan Merlo is member of the External Advisory Board (EAB) in the project “CLoud ARTificial Intelligence For pathology” (CLARIFY) proposal of MARIE Skłodowska-CURIE ACTIONS Innovative Training Networks (ITN-ETN). CLARIFY is a collaborative project between European Universities.
5. **Cancer epidemiology**. This research group has made great progress during the period with H Olsson as one of the initial contributors to the application for SRA EpiHealth. The extensive research has contributed to increased understanding of the genetic causes of breast cancer, melanoma, ovarian cancer and endometrial cancer with international contacts. These research collaborations involve contacts with Collaborative Group on Hormones and Breast Cancer; (Oxford, Europe, USA and Australia); Collaborative Group on Hormones and Ovarian Cancer (Oxford, Europe, USA and

Australia); IBCCS world-wide collaboration on *BRCA* carriers; Hereditary Breast Cancer Group, Toronto, Canada; Breast Cancer Demonstration Project, Southampton, UK; The CGG-ICGHBOC (cancer genetic group-international cancer genetic group for hereditary breast and ovarian cancer); GENOMEL and BioGenomel; word-wide collaboration on melanoma risk factors and melanoma genetics; International Melanoma Genetics Group, USA; Male Breast Cancer Group; and BCAC, Cambridge, UK, etc.

6. Clinical Epidemiology Unit/Musculoskeletal Epidemiology (www.clin-epi.com) has active collaborations with leading institutions across four continents (Europe, North America, Asia, and Australia), incl. but not limited to Oxford University, University of Nottingham, Erasmus MC, Boston University, Harvard, Nagoya University, etc. Team leader Englund further participates as funded co-applicant of several international collaborations and consortiums including funding from IMI (7.5 mill €) involving 25 industry members and academic institutions (The APPROACH consortium <https://www.approachproject.eu/>). Englund also serves as PI or co-investigator for several other European-funded collaborative projects, e.g. from Foundation for Research in Rheumatology (collaborations between Oxford, Nottingham, Erasmus MC, University of Oulu and LU).

7. Family medicine and clinical epidemiology. Family medicine has strong international collaborations and exchange of personnel and researchers with several universities in the US (Stanford University, University of California San Francisco, Virginia Commonwealth), Japan (Shimane University, Kyoto University), The German Cancer Research Center, the George Institute in Sydney, two research groups in China and with the University of Granada, which is currently starting a new research center in family medicine. The group has currently three large grants from National Institutes of Health; NIDA, NIAAA and NHLBI to Kristina Sundquist and an ERC Advanced Grant to Jan Sundquist, based on collaboration with US researchers.

8. Environmental epidemiology. Environmental epidemiology have a long history of collaborations and joint activities with internationally leading research groups. Currently, the group is together with three other research group at the Medical Faculty, Lund University, part of an EU-funded interreg-project, ReproUnion (www.reprounion.eu), encompassing the Danish Region of Capital and the Swedish Region of Scania with the overall aim to overcome infertility. ReproUnion, which had a 15 million € grant for the period 2015-2018 and has a 6 million € grant for the period 2019-2021, includes collaborations with researchers from prominent Universities such as Harvard and Stanford.

9. Health Economics. This is a strong and young research group with good collaborations and connections within medical faculty and economics department and also other departments at Lund University and other universities within (Gothenburg, Stockholm, Karlskrona) and outside Sweden (all continents). The research group (including researchers at the department of economics) is ranked 1 in the Nordic countries and the head of the group ([Gerdtham](#)) is currently the highest ranked health economist in Scandinavia. The research also has good connections with relevant government bodies such as the Swedish agency for health and care services analysis, ministry of finance, public health agency for Sweden, etc. Health Economics per definition and consequently the health economics group's work is multidisciplinary; in particular between medicine and (health) economics. The head of the group's position is shared between the medical faculty and the department of economics which is a strength for the health economics group since health economics at the medical faculty is more applied and policy oriented and health economics at the department is more theoretical and methodologically oriented which in combination provides useful opportunities for research at the cutting edge of health economics.

d. Diversity, integrity and ethics

We strive to promote gender equity that in SRA EpiHealth reaches 50/50 percent of men and women. Epidemiology is a discipline that by tradition attracts a diversity of scholars from different countries and backgrounds, which means that English is often the standard communication language within research groups. We constantly deal with ethical aspects of our research as it concerns both populations, cohorts and patients when for example register-based or biobank-based information has to be safe-guarded for integrity and all legal aspects. Researchers within SRA EpiHealth (e.g. Björk, Nilsson) provided input to the recent public inquiry SOU 2018:36 *Right to research - Long-term regulation of research databases*. Previously Nilsson was a member of the writing group for the task force led by Bengt Westerberg, *Unik kunskap genom registerforskning* (SOU 2014:45).

e. Quality in applications and publications

All our research applications and publications are based on extensive collaborations and joint authorship, sometimes with long lists of co-authors. We strive for excellence and this is supported by the well-recognized SRA EpiHealth that is focused on excellence in epidemiological research on a national and international level, and as such recognized by the Swedish Research Council and Lund University. Many of our publications are subject to internal discussions at seminars or more informal meetings to facilitate different perspectives in the analytical work. As we have listed seven Professors of epidemiology active within SRA EpiHealth in Lund/Malmö (Björk, Engström, Källén, Merlo, Rylander, Jan Sundquist, Kristina Sundquist), three Professors dedicated to genetic epidemiology in particular (Franks, Ohro-Melander, Olsson), and one Professor in Medical Research (Englund) also other researchers may benefit from their advice or co-authorship to improve quality of manuscripts.

B3. Quality ecosystem

Educational activities

SRA EpiHealth (Björk, Merlo and several other senior researchers) has developed a series of advanced courses in epidemiology, intended for a new generation of researchers. Methods as well as examples and actual data used in the courses are to the extent possible based on the data infrastructure (cohorts and biobanks) that SRA EpiHealth is responsible for. However, much of our educational efforts rely on temporary funding for such activities. We view long-lasting investments in education as an important but often neglected prerequisite for maintaining the strong position of Epidemiology at Lund University. Of special importance are the international contacts for education, for example the Blue Sky exchange program connecting the Lund and Harvard universities (Franks).

Research collaborations in industry, county councils and non-governmental organizations

We have a number of contacts with local, regional and national authorities, including the local county council *Region Skåne* (with Englund as Board representative), as probably the most important partner in epidemiological research, especially involving patients. One important example is the *Centre for Primary Care Research*, led by Jan Sundquist 2010-2019, and now by Kristina Sundquist 2019, a very productive research infrastructure that published more than 1300 peer-reviewed articles since the start in 2008. Such contacts with authorities and institutions are bi-directional as we provide information and reports to authorities, but also receive feed-back information on the societal relevance of our work. Another is the ongoing biobanking of musculoskeletal tissues, joint fluid and serum with ERC funding in collaboration with Region Skåne by Martin Englund. The extensive public health surveys conducted by Region Skåne regularly constitute an important data source for significant research within epidemiology, social medicine and public health. Some of our scholars are members of national committees, for example Läkemedelsverket, SBU, and TLV. Within SRA EpiHealth we especially

work with Socialstyrelsen (Karin Källén, 50% employed) and Statistics Sweden. This does not provide funding but a flux of ideas and applications for research.

Potential conflicts of interests in relation to collaboration

The Lund University advocates, and in fact demands, that we should develop extensive contacts with the surrounding society according to the so called Third Task. This means that we have had a number of contacts with the industry as well as smaller or medium-sized companies to strengthen our research. One example of the former is Astrazeneca Ltd, Mölndal, where Professor Gunnar Engström used to be a part-time employee during the period, and one example of the latter is OLINK Proteomics AB, Uppsala, providing biomarker technologies and analyses. In all our publications we have to declare conflicts of interest (COI) as a standard procedure. Among authorities that we collaborate with are Socialstyrelsen, Länsstyrelsen, etc.

We encourage such engagement and outreach, not only because our research quality depends on that, but also because this is in line with the overall Lund University Third Task strategy. In all engagement we have, however, to find an appropriate balance of time and efforts spent in relation to what research can gain. Sometimes it is also important to re-evaluate collaborations and even to terminate them if prerequisites, funding or availability of experts change over time.

B4. Transversal themes

Our contacts with the faculty level and central Lund University leadership

The every-day contacts for the research groups are with our departments of the Faculty of Medicine with regular meetings for the research group leaders. The Faculty and central University representatives are more engaged in the SRA EpiHealth, as this belongs to the twelve SRA´s of the University, spearheading excellence in research. For example, the Faculty has one representative (Martin L Olsson) in the Board of SRA EpiHealth.

We feel that more resources should be devoted to the recruitment of new PhD students as well as more senior researchers that could also act as tutors. The support for the SRA EpiHealth comes from the Research Council of Sweden since 2010, but channeled via the Lund University administration. Contrary to the support from other Universities to their SRA´s, the Lund University so far spent little funding on their own SRA´s, and this could improve. Guidance is provided from the Lund University level to SRA EpiHealth via regular meetings with the Vice Chancellor for infrastructures (Stacey Sörensen).

Some strengths and weaknesses in the current approach

The lack of funding from the Faculty and University level means that employment of external researchers or new PhD students rests on the resources of the senior researchers within each research group. As external funding based on applications is never secure for more than a limited period of time (1-3 years mostly) this means that it is difficult to recruit new staff or research students as the financial resources may disappear if applications for new funding are not successful.

Infrastructures

We critically need the access to data from infrastructures such as the Malmö population-based cohorts (<https://www.malmo-kohorter.lu.se/malmo-kost-cancer-och-malmo-forebyggande-medicin>) as well as LUPOP and the biobanks linked to the cohorts, for example the MISS cohort. Some of the biobank samples are stored at Region Skåne´s Biobank BD47, as a very important infrastructure.

There are many legal, practical and financial issues associated with the collection, storage and data management of our cohorts and the information provided via the biobanks storing samples. This means costs for transportation and storage, but also several questions regarding legal issues to be solved, for example when samples should be sent to other countries as part of international consortia collaborations. With recently more strict EU regulations (GDPR) and upcoming Brexit we expect even more legal problems to be solved when international collaborations should be developed, also including the complicated rules for sending samples outside EU, i.e. to the United States. Therefore, we also need legal advice and support of legal specialists at the Lund University.

We want to continue recruitment for MOS with new possibilities to perform family studies and missing heritability. On addition the SCAPIS study plans for a re-examination in coming years to enable studies of the pathogenetic processes underlying cardio-pulmonary diseases.

Collaboration with other SRA´s at Lund University

We are actively collaborating with SRA Exodiab (Orho-Melander, Nilsson) and to a lesser extent also SRA eSENCE (Källén).

This collaboration substantially strengthens the epidemiological research that is carried out within the Faculty of Medicine. In addition, four of the research group leaders (Nilsson, Björk, Orho-Melander, and Englund) are also Board members of SRA EpiHealth, and the fifth research group leader (Engström) is a Professor of Medical epidemiology, as financed to a major extent by the SRA EpiHealth. The sixth research group leader (Merlo) covers the important area of social epidemiology linked to SRA EpiHealth. In addition Health economics (Gerdtham) is developed as well as Environmental Epidemiology (Rylander, Källén), Family Medicine and Clinical Epidemiology (J Sundquist, K Sundquist), Cancer epidemiology (H Olsson) and Genetic Epidemiology (Franks, Orho-Melander), etc.

We want to further develop resources for bioinformatics and data-bases/cohorts. Other specific competences will be defined and recruited based on available resources.

There is also other SRA´s that are of importance for epidemiological research, for example SRA Exodiab for diabetes research when often population-based cohorts as well as quality registers of hospital care are needed. Besides SRA Exodiab, we also want to develop contacts with SRA NeuroPark, and SRA Biocare (soon transformed into the Lund University Cancer Centre, LUCC) as these SRA´s also deal with epidemiology, for example risk factors for dementia or cancer.

Summary and final remarks

Our general impression is that is a difficult task to assess all the research activities and collaborations that took place within our research groups and the SRA EpiHealth at LU during 2014-2019, the evaluation period, when Peter M Nilsson was Director and Marju Orho-Melander Vice-Director of SRA EpiHealth. Maybe the compilation of publications, as a way to show bibliometrics, is not enough to look for what we have achieved as a platform for future potentials. The SWOT analysis is rightly regarded as the core of the self-evaluation, and it should be sufficiently thorough, honest and informative to really be useful for future strategic planning. For this purpose we have expanded the SWOT analysis of SRA EpiHealth in more detail - see **Appendix** (page 12-15).

In the end, external funding is a summary of resources for our research potential of the past period 2014-2019, but our visions and research ideas, built on collaboration, is the hard currency of tomorrow. The application of H-index for analyses of individual achievements may also be questioned, but despite its limitations it is an objective way to analyze the impact of publications as measured by citations that forms the H-index statistics.

Peter M Nilsson drafted the first version of this summary that was later circulated. A joint discussion meeting for both the Lund University and Uppsala University parts of SRA EpiHealth was held on Thursday November 7th 2019 to discuss the new strategic plan 2020-2025 that was drafted by Professor Sölve Elmståhl, the new Director of the SRA from 2020 onwards.

Publications based on the EpiHealth-Elderly Cohort (Uppsala-Malmö) 2013-2019

1. Lind L, Elmståhl S, Bergman E, Englund M, Lindberg E, Michaelsson K, Nilsson PM, Sundström J. EpiHealth: a large population-based cohort study for investigation of gene-lifestyle interactions in the pathogenesis of common diseases. *Eur J Epidemiol*. 2013;28(2):189-97.
2. Lundström O, Manjer J, Ohlsson B. Smoking is associated with several functional gastrointestinal symptoms. *Scand J Gastroenterol*. 2016;51(8):914-22.
3. Ohlsson B, Manjer J. Physical inactivity during leisure time and irregular meals are associated with functional gastrointestinal complaints in middle-aged and elder subjects. *Scand J Gastroenterol*. 2016;51(11):1299-307.
4. Titova OE, Lindberg E, Elmståhl S, Lind L, Schiöth HB, Benedict C. Association between shift work history and performance on the trail making test in middle-aged and elderly humans: the EpiHealth study. *Neurobiol Aging*. 2016;45:23-29.
5. Roos V, Elmståhl S, Ingelsson E, Sundström J, Ärnlöv J, Lind L. Metabolic Syndrome Development During Aging with Special Reference to Obesity Without the Metabolic Syndrome. *Metab Syndr Relat Disord*. 2017;15(1):36-43.
6. Lind L, Elmståhl S, Ärnlöv J. Change in Body Weight from Age 20 Years Is a Powerful Determinant of the Metabolic Syndrome. *Metab Syndr Relat Disord*. 2017;15(3):112-117.
7. Roos V, Elmståhl S, Ingelsson E, Sundström J, Ärnlöv J, Lind L. Alterations in Multiple Lifestyle Factors in Subjects with the Metabolic Syndrome Independently of Obesity. *Metab Syndr Relat Disord*. 2017;15:118-123.
8. Lind L, Ärnlöv J, Lampa E. The Interplay Between Fat Mass and Fat Distribution as Determinants of the Metabolic Syndrome Is Sex-Dependent. *Metab Syndr Relat Disord*. 2017;15(7):337-343.
9. Moding M, Ohlsson B. The role of fermentable carbohydrates and beverages in the symptomatology of functional gastrointestinal disease. *Scand J Gastroenterol*. 2017;52(11):1224-1234.
10. Cornelis MC, Gustafsson S, Ärnlöv J, Elmståhl S, Söderberg S, Sundström J, Michaëlsson K, Lind L, Ingelsson E. Targeted proteomic analysis of habitual coffee consumption. *J Intern Med*. 2018;283(2):200-211.
11. Kamble PG, Gustafsson S, Pereira MJ, Lundkvist P, Cook N, Lind L, Franks PW, Fall T, Eriksson JW, Ingelsson E. Genotype-based recall to study metabolic effects of genetic variation: a pilot study of PPARG Pro12A1a carriers. *Ups J Med Sci*. 2017;122(4):234-242.
12. Kamble PG, Gustafsson S, Pereira MJ, Lundkvist P, Cook N, Lind L, Franks PW, Fall T, Eriksson JW, Ingelsson E. Genotype-based recall to study metabolic effects of genetic variation: a pilot study of PPARG Pro12A1a carriers. *Ups J Med Sci*. 2017;122(4):234-242.
13. Beijer K, Lampa E, Sundström J, Nilsson PM, Elmståhl S, Pedersen NL, Lind L. Interaction between physical activity and television time on blood pressure level: cross-sectional data from 45 000 individuals. *J Hypertens*. 2018;36(5):1041-1050.
14. Cai GH, Theorell-Haglöw J, Janson C, Svartengren M, Elmståhl S, Lind L, Lindberg E. Insomnia symptoms and sleep duration and their combined effects in relation to associations with obesity and central obesity. *Sleep Med*. 2018;46:81-87.
15. Lind L. Population-based cardiovascular cohort studies in Uppsala. *Ups J Med Sci*. 2019;124(1):16-20.

16. Figarska SM, Gustafsson S, Sundström J, Ärnlöv J, Mälarstig A, Elmståhl S, Fall T, Lind L, Ingelsson E. Associations of Circulating Protein Levels With Lipid Fractions in the General Population. *Arterioscler Thromb Vasc Biol.* 2018; 38(10):2505-2518.
17. Lind L, Elmståhl S, Ingelsson E. Cardiometabolic Proteins Associated with Metabolic Syndrome. *Metab Syndr Relat Disord.* 2019;17(5):272-279.
18. Stattin K, Lind L, Elmståhl S, Wolk A, Lemming EW, Melhus H, Michaëlsson K, Byberg L. Physical activity is associated with a large number of cardiovascular-specific proteins: Cross-sectional analyses in two independent cohorts. *Eur J Prev Cardiol.* 2019;26(17):1865-1873.
19. Warensjö Lemming E, Byberg L, Stattin K, Ahmad S, Lind L, Elmståhl S, Larsson SC, Wolk A, Michaëlsson K. Dietary Pattern Specific Protein Biomarkers for Cardiovascular Disease: A Cross-Sectional Study in 2 Independent Cohorts. *J Am Heart Assoc.* 2019;8(11):e011860.
20. Beijer K, Nowak C, Sundström J, Ärnlöv J, Fall T, Lind L. In search of causal pathways in diabetes: a study using proteomics and genotyping data from a cross-sectional study. *Diabetologia.* 2019; 62(11):1998-2006.
21. Theorell-Haglöw J, Lemming EW, Michaëlsson K, Elmståhl S, Lind L, Lindberg E. Sleep duration is associated with healthy diet scores and meal patterns: results from the population-based EpiHealth study. *J Clin Sleep Med.* 2019 Nov 26. pii:jc-19-00212. [Epub ahead of print] PubMed PMID: 31770092.

APPENDIX. Detailed SWOT analysis for SRA EpiHealth**a) Maintaining or reaching *research quality* of the highest international standard and to reach an international leading position within our field of research**

<p>Strengths</p> <ul style="list-style-type: none"> • A very vibrant, growing, productive and innovative environment of researchers, including a larger national and international network. • The Epihealth environment consists of researchers from different and diverging fields, but in collaboration. • We produce research and papers of highest international standard. • Areas of special importance include genetic studies of common diseases. • Rich databases, cohorts and biobanks exist both at LU and UU. 	<p>Weaknesses</p> <ul style="list-style-type: none"> • Advanced molecular epidemiology research contains very long lists of authors. Difficulties exist for Swedish researchers to negotiate leading positions in author lists. • The resources for epidemiological research (IT sciences, biostatistics, bioinformatics, funding) are better at many foreign research institutes. A need exists for access in Sweden to better infrastructures for technical platforms and bioinformatics.
<p>Opportunities</p> <ul style="list-style-type: none"> • New access to infrastructure for advanced molecular epidemiology (national SciLife resource). • Possibility to link up more closely with other large-scale population-based cohort in Sweden (LifeGene, age range: 0-45 years, SCAPIS), and to use the resources in collaboration. • The leading epidemiological study on a global scale (Framingham Heart Study, USA) has stopped its screening activities in 2013 – leaving room for advanced European cohort studies, collaborations and networks of biobanks (BBMRI, BIS). 	<p>Threats</p> <ul style="list-style-type: none"> • International collaboration and data sharing is sometimes difficult. • We need to have a strategy in relation to UK Biobank • Need for better supporting laws and regulations, • Lack of funding and support to infrastructure. • Dependence on easy access to national registers. It is necessary that changes in national and EU laws and regulations exempt research when new ID protection legislation is discussed (GDPR).

In summary, we are proud of our achievements and expect great opportunities for SRA EpiHealth as the request for epidemiological competence and results are growing. In fact, our environment has created excellent research opportunities, reflected in the highest number of scientific papers published annually by all strategic research areas, and also keeping a gender balance. We have benefitted from the collaboration between Lund and Uppsala universities, based on regular meeting, and joint research projects. The EpiHealth screening cohort was first started in Uppsala, later in Malmö, now collecting data from 24,000 subjects (45-75 yrs).

Of special relevance is to develop the practical applications in finding new drug targets, functional food products, but also surveillance models of health and the environment. Of all the different weaknesses and threats we face, the lack of sufficient financial support is one of the most alarming, but also the negative impact of too restrictive laws and regulations could cause us to slow down the research activities if data will be less easily available.

b) Linking the strategic research areas with the *needs of societal organization and the business sector*

<p>Strengths</p> <ul style="list-style-type: none"> • Strong links exist with societal organizations e.g. the National Board on Health and Welfare, Statistics Sweden, Food Products Agency and the County Council authorities. • We have developed business sector contacts with both large enterprises (i.e. Astrazeneca Ltd.) and with smaller biotech SME's or private laboratories (i.e. OLINK). 	<p>Weaknesses</p> <ul style="list-style-type: none"> • It has been difficult to develop patents for new technical products.
<p>Opportunities</p> <ul style="list-style-type: none"> • We can deliver new knowledge on biological mechanisms and potential new drug targets based on developments in molecular biology, biomarkers and register follow-up analysis using personal ID, for addressing unmet medical needs. • The developments in nutritional- and genetic epidemiology (NGE), including studies of the oral and gut microbiomes, will open up a door for new functional food products. • Further develop the mapping of environmental health hazards in collaboration with local authorities. If the quality registers in the health care system can be linked to biobanks, we will have the opportunity to look for prognostic factors in patients. 	<p>Threats</p> <ul style="list-style-type: none"> • Many biotech and drug pharmaceutical companies are leaving Sweden, and this leads to a reduced business sector for drug development in Sweden and less work positions available in the private sector. • There is a trend for stricter handling of data by some authorities, even to the degree of questioning our ethical permissions (already approved by regional ethics councils) to use our cohort data-bases for annual register updates from national registers. This is a structural weakness of the Swedish system and a potential threat of relevance for epidemiological research, as we lag behind countries with better infrastructures and laws.

In summary, in collaboration with Uppsala we have built a very strong link with societal organizations such as the National Board on Health and Welfare, for example related to the Medical Birth Register, and with Statistics Sweden. Other public institutions that we work with include the Food Products Agency and the local County Council authorities. This has led to formal collaborations of great importance related to, for example, adverse drug reaction register for teratogenic effects, pregnancy surveillance systems, dietary intake web-form assessments, and surveillance of environmental hazards for health.

Our contacts with the business sector have developed but are currently threatened by a trend for some enterprises to leave Sweden and concentrate research resources abroad. We hope to develop the contacts with SME's involved in research and also private laboratories, i.e. for analyses of oral and gut microbiota patterns.

c) Cultivating *collaborations* with other universities and non-academic organizations

<p>Strengths</p> <ul style="list-style-type: none"> • Prosperous and growing networks and collaborations with other universities and research institutes, based on link between LU and UU. • We have contacts with leading universities and institutes such as Harvard, Stanford, Broad Institute, Boston, Oxford, Paris, and the George Institute in Sydney. • We benefit from contacts with non-academic organizations e.g. the Heart- and Lung Foundation (HLF) of Sweden and its epidemiological SCAPIS project, but also with patient associations. • EpiHealth is taking a leading role when organizing national meetings on epidemiology and biobank issues. 	<p>Weaknesses</p> <ul style="list-style-type: none"> • Risk of lack of time, motivation and funding to set up seminars or joint activities if academic partners work at long distance from each other. • Even if we have some resources, there is a need to recruit more national and international skilled staff, in for example bioinformatics and biostatistics, as well as experts in IT systems and advanced biobanking science.
<p>Opportunities</p> <ul style="list-style-type: none"> • To strengthen our links with other universities at different levels is a great positive challenge. • EU funding is obtained within the ERC and Horizon 2020 program, when members of our environment have applied and also been granted. • Collaboration with UK Biobank could bring opportunities for replication and validation of findings in our own cohorts 	<p>Threats</p> <ul style="list-style-type: none"> • There is a risk that the financial and political situation in Sweden will be less stable and enterprises leave the country in the coming five years. This could affect the possibilities for doing joint projects and the possibility for finding employment in the business sector for our trained staff and PhD-students. • Risk that the public spending for the social sector may be subject to budget cut-downs, even for research.

In summary, together with UU we strive to develop contacts with leading universities and institutes such as Harvard, Stanford, Broad Institute in Boston, Oxford, Paris, and the George Institute in Sidney. This has so far led to fruitful collaborations and a number of excellent publications. In a similar way, the participation in broad research collaborations has increased, for example within the EPIC and EGIR networks, leading to joint projects and papers.

We are influenced by trends in the global economy and concentration in for example the pharmaceutical industry. Also the public spending for the social sector may be subject to budget cut-downs. A threat to the integration between research and education may arise if foreign students will be less inclined to go to Sweden for studies or research, a factor that could be influenced by university policies and increased costs for education. We need foreign undergraduates and post-docs, as well as advanced researchers, to choose Sweden for their future work and career - otherwise the man-power to build excellence in research will be too restricted. In the future we will further strengthen information campaigns about EpiHealth.

d) Strengthening the link between *research and education*

<p>Strengths</p> <ul style="list-style-type: none"> • We have developed the ties linking research and education, both on the under-graduate level (courses, lectures, tutoring of students' papers) and on the PhD-student level (annual advanced courses in epidemiology, seminars, week-end retreats, Örenäs courses, and tutorship). • Exchange of research students, especially with neighboring countries such as Denmark, Germany and The Netherlands. • A PhD exchange program called "Blue ScY" was launched in 2013, building on the triangle collaboration between LU, Umeå University, and Harvard University. 	<p>Weaknesses</p> <ul style="list-style-type: none"> • Too few senior teachers are available to offer a full variety of courses and teaching activities in epidemiology, statistics and molecular methods. • We need to recruit even more foreign students and post-docs to our environment.
<p>Opportunities</p> <ul style="list-style-type: none"> • The opportunity to strengthen the link between research and education is visible through activities on the <i>local level</i> (reforming and revising the curriculum for teaching in epidemiology and medical statistics), the <i>national level</i> (between LU and UU), but also on the <i>international level</i> (exchange programs for PhD students), that can be further developed. 	<p>Threats</p> <ul style="list-style-type: none"> • The integration between research and education can be affected if foreign students will be less inclined to go to Sweden for studies or research, a factor that could be influenced by university policies and increased costs for education. • The higher education (under-graduate training, PhD students) that we want to provide is limited by the restricted number available of senior lecturers and tutors, as real experts in special areas are few.

In summary, we aim for more integration both within Sweden, between universities and institutions of higher education, and with Europe and the rest of the world. Exchange programs exist with European universities and existed with Harvard University, organized by SRA EpiHealth.

Our partner university in Uppsala is of utmost importance for our strategy to be successful in building academic networks and collaborations, for example the Uppsala Clinical Research (UCR) Unit (<https://www.ucr.uu.se/sv/>), with its ambition to support clinical epidemiology based on quality registers in the health care system, i.e. SWEDEHEART for clinical cardiology (<https://www.ucr.uu.se/swedeheart/>). This also applies to COHORTS.SE for national collaboration between cohorts. Our general plan is to develop our own teaching activities (seminars, retreats, symposia) but also to support and be active in other PhD-training activities, for example a SRA PhD school for research in ageing, gerontology and geriatrics SWEAH (<https://www.sweah.lu.se/>), with LU leadership and active participation of SRA EpiHealth. We therefore intend to create new positions for teaching.