Biennial report
2015 – 2016

ARC
AGING RESEARCH CENTER

Stockholm University

Karolinska Institutet

Production: Aging Research Center
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Contents

Message from the former director

Several events and circumstances at the Aging Research Center (ARC) have made the last two years, 2015 and 2016, very important years for our center. It is my pleasure and honor to highlight them in this introduction, not only as valuable memories but also as inspiration for the future development of ARC.

First, during this time, a generational shift started, as two founders of ARC retired. Mats Thorslund and Marti Parker have been the core of the center, working since the late 1990s on ARC's design, contributing to our two key applications to Forte, and leading the social gerontology sector with competence and enthusiasm. This is the perfect occasion to thank them both for their commitment, engagement, and enthusiasm. Mats: the field of gerontology in Sweden has developed and entered the international arena thanks to you and your work. Marti: your creativity, multidisciplinary, and multicultural perspective have enriched us not only in our work, but also as people.

Second, other researchers also left ARC during this period to accept prestigious new appointments. Miia Kivipelto received Stockholm Sjukhem's professorial chair in clinical geriatrics, and Hui-Xin Wang became professor of social epidemiology at the Stockholm University. Moreover, Ingemar "Pingo" Kåreholt became professor of gerontology at Jönköping University but will continue to spend part of his working time at ARC. Finally, Kristina Johnell won a professorship in geriatric pharmaco-epidemiology at ARC, becoming one of the youngest professors at Karolinska Institutet. We are very proud of their achievements. When ARC researchers develop, it is a joy for all of us, and we are sure that we will continue fruitful collaborations with all these brilliant colleagues.

Third, ARC researchers have published many findings relevant to the scientific, public health, and medical fields. A summary is provided later in this report. My feeling is that now, after 16 years of intensive work, we have reached the skills and the critical mass that allow us to make a broad impact on our research field and beyond. We are providing new ideas, new research avenues, new assessment tools, and new approaches to relevant topics such multimorbidity, cognitive reserve, and social gradients in health.

Fourth, two program grants obtained from Forte in 2016 ensure solid support for ARC's research activities for the next six years. Both programs take a multidisciplinary approach in which researchers from the three sectors (geriatric medicine, social gerontology, and psychology) collaborate to detect new pathways to longer and healthier lives and to decrease inequalities among older adults.

Fifth, our ten-year grant from Forte for creating a center of excellence in aging research ended in 2016. It is not easy to run a center without any specific financial support; we must now rely exclusively on research grants. Nevertheless, we have made the decision to maintain ARC as a national center with the mission of carrying out high-quality research, educating new generations of researchers, spreading our findings outside academia, and promoting aging research. We will maintain this commitment as long as we think it is relevant to Karolinska Institutet, to the international scientific community, and to our aging society—and as long as our personal efforts are sufficient without any specific investment from government, research councils, or academia. We know that this will not be easy, but we accept the challenge.

Lastly, ARC now has a new director, Johan Fritzell, who started in October 2016. It is really my pleasure to leave the leadership of the center to such a committed and experienced colleague. Johan moved to ARC only a few years ago, but his contribution to the development of the center has already been crucial. Thus, the past two years were also my final years as ARC's director. These last ten years have been a time of intensive work but have brought so many great achievements, positive memories, and a level of fun and enthusiasm that it is very difficult to find in other workplaces. I am as sure about that as I am sure that all our achievements would not have been possible without the support of Karolinska Institutet; the Department of Neurobiology, Care Sciences and Society; and Forte. But most of all: my work would have been much harder and less fruitful without you—the fantastic ARC people who made each day of my last ten years at work an inspiring adventure.

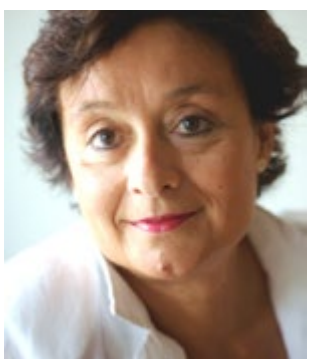


Photo: Tom Bellander

Laura Fratiglioni
Former Director of ARC

ARC futures – message from the present director

I have no doubts that seen from an international point of view, the achievements of the ARC are formidable. Over a relatively short time span, ARC has become a well-renowned, multidisciplinary center with a high output in several domains. This is thanks to contributions of all co-workers, but the importance of my predecessor Professor Laura Fratiglioni cannot be overestimated. Laura is not only an international top scholar in epidemiological aging research. She has a great passion for ARC as a center, and during my relatively short period at ARC I have witnessed the importance she puts on the workplace as such on many occasions. Needless to say, I have large shoes to fill, but that is also a fascinating part of the job.

After a ten-year period of being the largest Forte Centre, ARC now enters a new era. Although such changes are challenging in many respects, they also bring opportunities. We are increasingly successful in receiving external grants; we definitely continue to develop and expand our multidisciplinary face; we attract excellent researchers from abroad; and our upcoming researchers have high career opportunities at other places in Sweden or abroad. Science has no borders, and international collaborations often mean new perspectives on and ideas about important subjects. A prime imperative for me will therefore be to continue this internationalization.

Our broader research topic, aging, is also a truly international one. By and large, the aging process, which Sweden shares not only with other high-income countries but even more with middle- and low-income countries, is a grand challenge for society. Most likely our perception of the life course and of aging will also change. The aging of populations, which is a success story, is a key challenge for the 21st century. The importance of our work and our opportunities to make an impact thereby also increase.

It would be foolish of me, as a director of ARC, to dictate or suggest in more detail research questions that we should analyze and try to answer. Such questions are much better dealt with in our sectors or in smaller multidisciplinary research groups. However, at a more general level, ARC having been around for more than 15 years, is now in a good position to break into new fields of aging research and *to be* the frontier. Thus, ARC is well-positioned not only to conduct aging research that is well-respected in the national and international research community, but also to actually become a "game changer" in aging research. We have the necessary prerequisites: ARC researchers are talented and have excellent training, we have access to excellent data that to an increasing extent also incorporates register data, and we conduct multidisciplinary work that still has a solid basis in our disciplinary backgrounds.

A last important point for such an optimistic scenario is to have a good, friendly, and open working environment in which all employees have a voice. In such an atmosphere, high-quality research can flourish!

Photo: Thomas Carlgren

Johan Fritzell
Present Director of ARC

Introduction

The Aging Research Center (ARC) was established in 2000 by Karolinska Institutet (KI) and Stockholm University (SU). It was until December 31, 2016, a "Center of Excellence," supported by two consecutive grants from the Swedish Research Council for Health, Working Life and Welfare (Forte).

ARC is a physical center that shares premises with its closest collaborators, the Stockholm Gerontology Research Center (*Äldrecentrum*, supported by Stockholm City and the Stockholm County Council) and the Swedish Dementia Centre (*Svenskt Demenscentrum*, supported by the Swedish National Board of Health and Welfare). This close proximity facilitates the sharing of research findings with an audience beyond academia. Together with the two other centers, ARC supports the aging research magazine *Äldre i Centrum*.

ARC is internationally renowned for its research on the health status of older adults, trends and inequality among old people, brain aging, and prevention of dementia. Our research activities are characterized by:

1. A focus on health in aging, the goal of which is preventing, postponing, or decreasing morbidity and disability in old age.
2. An acknowledgement of the importance of life course processes on health and functioning at old age.
3. A focus on both individual and social group differences in late life health and disability.
4. A multidisciplinary approach that includes medicine, social gerontology, psychology, and epidemiology.
5. Creation of large databases from population-based studies on aging and health.
6. Access to other large databases on aging via national and international collaborations.
7. Integration of epidemiological and social science studies with clinical and molecular work.
8. Contribution to improved treatment and care of elderly people.
9. Special attention to neuroscience with focus on neural correlates of cognitive functions and prevention of brain aging.
10. Implementation of intervention studies to prevent cognitive decline, dementia, and multimorbidity.

Between 2008 and 2015, the research environment at ARC was strengthened by the creation of the National Graduate School for Aging Research, which was also supported by Forte. The school used the competencies of partners at multiple universities across Sweden to give PhD students a theoretically and methodologically multidisciplinary background.

Vision and mission

ARC envisions a world in which all people can age with dignity and security through improvements in health, equal access to the best social and medical services, and full integration in society.

ARC's mission is to understand the biomedical and psychological aspects of the aging process in relation to social and physical contexts across the entire lifespan. Our ultimate goal is to improve the health and well-being of older individuals by meeting the challenges and embracing the opportunities presented by the aging population.

Organization

Organization and leadership

ARC is a center at KI; it is part of the Department of Neurobiology, Care Sciences and Society (NVS). It is led by a board that includes representatives from Forte, Karolinska Institutet, Stockholm University, and the Stockholm Gerontology Research Center.

ARC consists of three sectors: medicine, psychology and social gerontology. The responsibility for scientific, organizational, and financial issues, including those related to staff, external contractors, and changes in administrative staff, is shared by the members of the Steering group, which is led by ARC's director. ARC's steering group consists of ARC's director, Johan Fritzell; the Division Head; Kristina Johnell; the Deputy Head of Division, Jonas Persson; senior representatives from each sector; and three junior research representatives. This group meets once a month. Daily decisions and actions regarding promotion, finances, staff, and work environment are made by the Executive group.

ARC has a yearly planning day (ARC day) where both scientific updates are presented and organizational issues are discussed. The sectors are also presenting new research findings, discuss collaboration, and socialize on retreats which are organized regularly. At the ARC Junior Researcher Group retreat, graduate students and post-docs meet every year to work on collaboration, give updates on the latest research, and practice their presentation skills.

ALL AT ARC

Photo: Maria Yohuang

Members of the Aging Research Center.

BOARD

Photo: Maria Yohuang

Back row: Jonas Persson, Chatrin Engbo, Gabriel Romanus, Barbro Westerholm, and Bengt Winblad.
Front row: Bo Malmberg, Sven Britton, Anne Ekdahl, Laura Fratiglioni, and Kristina Johnell.

2015

MEMBERS

Bo Malmgren, Professor, SU, Chair
Nancy Pedersen, Professor, KI, Vice Chair
Marta Szebehely, Professor, SU
Cecilia Magnusson, Professor, KI
Anne Ekdahl, Chair of the Swedish Geriatric Association
Gabriel Romanus, former Member of Parliament
Sven Britton, former Member of Parliament, Senior Professor, KI
Barbro Westerholm, Member of Parliament
Chatrin Engbo, Director of the Stockholm Gerontology Center

ADJUNCT MEMBERS

Maria Eriksdotter, Professor, Head of NVS, KI
Laura Fratiglioni, Professor, Director of ARC
Bengt Winblad, Professor, Co-director of ARC
Kristina Johnell, Associate Professor, Head of Division, ARC
Jonas Persson, Senior Researcher, Deputy Head of Division, ARC

2016

MEMBERS

Bo Malmgren, Professor, SU, Chair
Nancy Pedersen, Professor, KI, Vice Chair
Marta Szebehely, Professor, SU
Cecilia Magnusson, Professor, KI
Martin Annetorp, Chief Operating Officer, Stockholm County Council, Health Care Services
Gabriel Romanus, former Member of Parliament
Sven Britton, former Member of Parliament, Senior Professor, KI
Barbro Westerholm, Member of Parliament
Chatrin Engbo, Director of the Stockholm Gerontology Center

ADJUNCT MEMBERS

Maria Eriksdotter, Professor, Head of NVS, KI
Laura Fratiglioni, Professor, Director of ARC (until September 30, 2016)
Johan Fritzell, Professor, Director of ARC (from October 1, 2016)
Bengt Winblad, Professor, Co-director of ARC (until September 30, 2016)
Kristina Johnell, Professor, Co-director (from October 1, 2016), Head of Division, ARC
Jonas Persson, Senior Researcher, Deputy Head of Division, ARC

SECTOR MEDICINE

Photo: Maria Yohuang

Back row: Kristina Johnell (Head of Division), Johan Fastbom, Weili Xu, Lucas Morin, Anna-Karin Welmer, Laura Fratiglioni (Director), Linda Rettenwander, Anna Marseglia, Francesca Mangialasche, Hui-Xin Wang, Rui Wang, and Barbara Caracciolo.
Front row: Giola Santoni, Krister Håkansson, Debora Rizzuto, Emerald Heiland, and Mozhu Ding.
The sector was led by Laura Fratiglioni, Johan Fastbom, Kristina Johnell, and Miia Kivipelto.

SECTOR PSYCHOLOGY

Photo: Maria Yohuang

Back row: Bárbara Avelar Pereira, Jonna Nilsson, Neda Kaboodvand, Yvonne Brehmer, George Samrani, Alexandra Pantzar, Dominika Seblova, Benjamín Garzón, Alexander Lebedev, Alexandra Ek, Nina Becker, Grégoria Kalpouzos, Claudio Brozzoli, and Alireza Salami.
Front row: Cecilia Stenfors, Goran Papenberg, Lars Bäckman, Erika Jonsson Laukka, and Jonas Persson (Deputy Head of Division). The sector is led by: Lars Bäckman and Martin Lövdén.
The sector was led by Martin Lövdén and Lars Bäckman

SECTOR SOCIAL GERONTOLOGY

Photo: Maria Yohuang

Back row: Johan Rehnberg, Hanna Berndt, Stefan Fors, Pär Schön, Susanne Kelfve, Neda Agahi, Josephine Heap, Harpa Sif Eyjólfsdóttir, Alexander Darin Mattsson, and Linda Hols-Salén.
Front row: Johan Fritzell, Carin Lennartsson, Ingemar Kåreholt, Marti Parker, och Lena Dahlberg.
The sector was led by Johan Fritzell and Carin Lennartsson.

ADMINISTRATIVE AND TECHNICAL STAFF

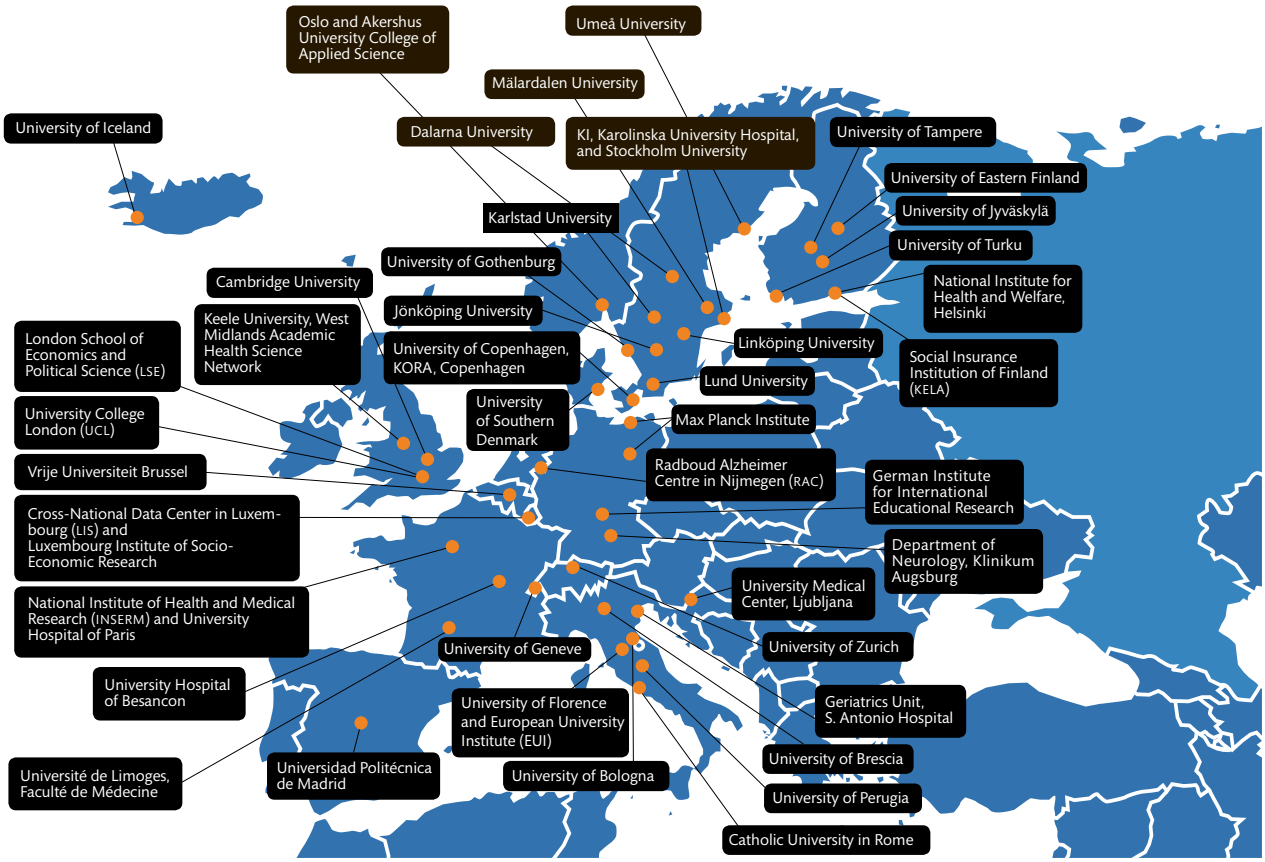
Photo: Maria Yohuang

Vanessa Suthat, Kimberly Kane, Lena Ragert-Blomgren, Johanna Bylund, Cecilia Annerholm, Alexandra Ek, Maria Wahlberg, and Maria Yohuang.

**Please note that not all members of staff were present when the sector pictures were taken.*

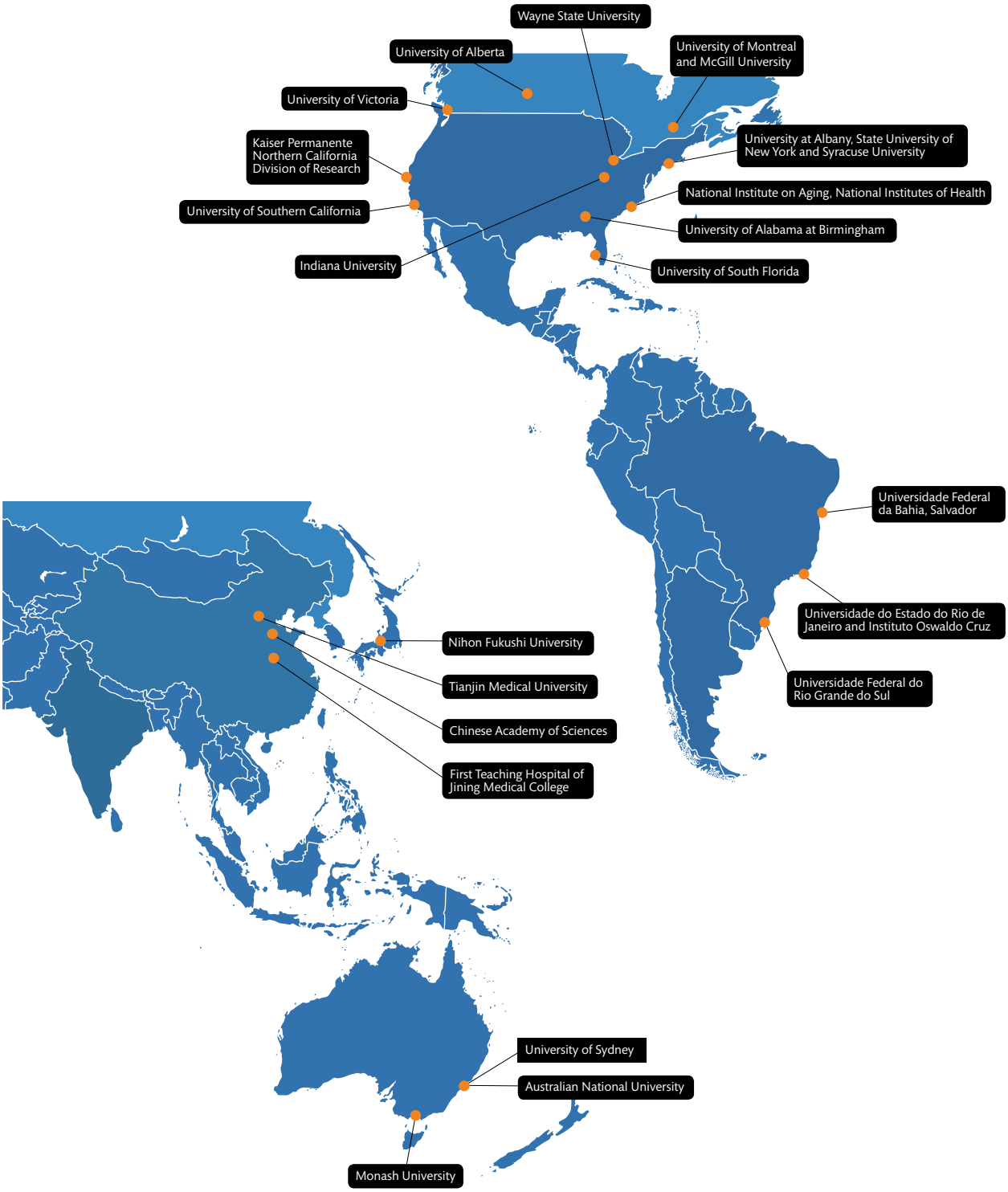
Collaboration around the world

ARC has collaborators in Sweden, Europe, Asia, Australia, North America, and South America.



European Union (EU) collaborations involving ARC researchers:

- European Institute of Innovation & Technology (EIT) Health, a node in the EU-funded Knowledge and Innovation Community (KIC) network
- The European Study of Cohorts for Air Pollution Effects (ESCAPE)
- The European Prevention of Alzheimer's Dementia (EPAD) Consortium
- Healthy Ageing Through Internet Counselling in the Elderly (HATICE)
- EU Joint Programming Initiative–Neurodegenerative Disease Research (JPIND)
- EU Joint Programming Initiative–More Years Better Lives (JPImybl)
- Multidimensional Prognostic Indices (MPI-age)
- New Dietary Strategies Addressing the Specific Needs of the Elderly Population for Healthy Ageing in Europe (NU-AGE)
- CoSTREAM - A multidisciplinary approach to understand the link between stroke and Alzheimer's
- European Social Policy Network (ESPN), European Commission


Wayne State University
University of Alberta
University of Montreal and McGill University
University of Victoria
Kaiser Permanente Northern California Division of Research
University at Albany, State University of New York and Syracuse University
National Institute on Aging, National Institutes of Health
University of Southern California
University of Alabama at Birmingham
Indiana University
University of South Florida
Universidade Federal da Bahia, Salvador
Universidade do Estado do Rio de Janeiro and Instituto Oswaldo Cruz
Nihon Fukushi University
Tianjin Medical University
Universidade Federal do Rio Grande do Sul
Chinese Academy of Sciences
First Teaching Hospital of Jining Medical College
University of Sydney
Australian National University
Monash University

Guest researchers – highlights

ARC has guest researchers from all over the world. This section highlights the experiences of a selection of our guest researchers. A complete list of guest researchers from 2015 to 2016 is included in an appendix at the end of the report.

BENJAMIN SHAW

Professor at the School of Public Health and Director of the Center for Social and Demographic Analysis, University at Albany, State University of New York

"I first visited ARC for a 6-month stay in 2011. Since then I have been back several times, most recently for a 6-week stay in April and May of 2016. Several researchers in the Social Gerontology Sector, particularly Neda Agahi and Stefan Fors, have become some of my closest collaborators. My visits to ARC have been extremely rewarding, as they have afforded me the opportunity to work with rigorous and innovative data (SWEOLD) in a uniquely collegial environment. It is not an exaggeration to say that I have become a better researcher because of my visits to ARC. In my mind, ARC is a model for high-quality interdisciplinary research and training."

Photo: Mark Schmidt

BRENT SMALL

Professor and Director of the School of Aging Studies, University of South Florida, Tampa, Florida

"I visited ARC between September 1 and 8, 2015. During my stay, I met with several students and scientists to learn about their research. I also presented a research talk entitled, "Is Cancer a Risk Factor for Cognitive Decline in Late Life?" in which I discussed my recent work on chemobrain, or cognitive difficulties that often follow the treatment for cancer. After my talk, I discussed the possibility of collaborating on this topic with researchers from ARC using the rich data that they have collected. I greatly enjoyed my visit and it was amazing to see how this research group has grown over the years."

Photo: Rosa Diaz

GIULIA GRANDE

Resident in Neurology, University of Milan, Italy

"I am a resident in neurology from Milan, Italy, and arrived at ARC in January 2016 to start a six-month internship as a guest researcher in the medical group. Under the guidance of Professor Laura Fratiglioni, Debora Rizzuto, and Anna-Karin Welmer, I started a project on the prognosis of cognitive frailty in older people. The friendly and supportive atmosphere, together with the inclusive and stimulating environment engaged me to the point of prolonging my stay at ARC for one more year. The experience was so inspiring that I decided to apply for a PhD position at ARC."

Photo: Johanna Bylund

LEI FENG

Research Assistant Professor, Department of Psychological Medicine, Yong Loo Lin School of Medicine, National University of Singapore, Singapore

"I visited ARC from June to October 2016 with support from Forte. During my stay, I worked with Chengxuan Qiu and Yajun Liang on a research project entitled "Trends in the prevalence of cognitive impairment in China, 2002 to 2014." We found very interesting results from this project and will publish the results as an original research article. I worked with Krister Håkansson in organizing a social event and brainstorming session on "Music as an intervention to prevent or delay dementia" and contributed to one of his research projects, "Being alone and feeling lonely in mid-life and the risk of dementia in late life." I delivered a public lecture on "Culture and aging research" at ARC and met several researchers to exchange ideas and discuss common research interests. Indeed, the research visit was highly productive and fruitful. I enjoyed my time at ARC and in Stockholm and look forward to new collaborations and academic exchange with ARC researchers."

Photo: Fengxia Liu

LINDA KRIDAHL

PhD student, Department of Sociology,
Stockholm University

"I visited ARC November 2016 for a month as a guest PhD student. At my own department, I am the only one that studies retirement timing and older people. The motivation for my stay at ARC was that I wanted to learn from experienced researchers that study older people and aging. Although the visit was short, I learned a lot about studies on older people. I met several of ARC's researchers, who were very welcoming and friendly. The atmosphere at ARC was open-hearted, and the researchers always had time to discuss various research topics, especially among the PhD students. I am also grateful to Carin Lennartsson for inviting me to stay at ARC and for giving me insight on how I, for instance, possibly could use SWEOLD in my postdoc project. I am additionally grateful for all the good advice she gave me. The visit was very enjoyable, and I look forward to visiting ARC again if given the opportunity."

Photo: Johanna Palm

Research

Research

This section briefly presents a selection of research findings from the past two years. It also contains information about research infrastructure, scientific production, and data sets. Researchers from ARC continue to produce a large number of published papers, many published in high impact journals.

Photo: Selma Wolofsky

NVS's Head of Department, Maria Eriksdotter, and Johan Fritzell signing the agreement for the project on Social Inequalities in Ageing (SIA).

Research infrastructure and larger collaborative projects at ARC

ARC plays a major role in large ongoing studies of aging, including SNAC-K, SNACK-MRI (a population-based magnetic resonance imaging [MRI] study conducted as part of SNAC-K), the Kungsholmen Project, the Swedish Panel Study of Living Conditions of the Oldest Old (SWEOLD), and the Swedish Centenarian Survey (part of the Five Country Oldest Old Project, 5-COOP). The af Jochnick Center initiated and participates in the groundbreaking COBRA project. Hjärnlabbet is an experimental laboratory for studies on cognitive intervention and neural plasticity. The large-scale Nordic program Social Inequalities in Ageing (SIA) involving universities in all Nordic countries and led from ARC was initiated. Information from these databases and collaborations forms the basis of many of our most important research findings.

ARC collaborates closely with researchers responsible for other large ongoing studies: the SNAC-K Care System Study; Cardiovascular Risk Factors, Aging and Dementia (CAIDE); the European Dementia Prevention Initiative; FINGER; the Betula Project; Dementia in Swedish Twins; Healthy Aging Through Internet Counselling in the Elderly (HATICE); Multimodal Preventive Trials for Alzheimer's Disease: Towards Multinational Strategies (MIND-AD); the Swedish Level of Living Survey; the Luxemburg Income Study (LIS); and the Survey of Health, Ageing and Retirement in Europe (SHARE).

At ARC we use various national registers, including the Swedish Prescribed Drug Register, the National Patient Register, and the Cause of Death Register. Located at the National Board of Health and Welfare, the Swedish Prescribed Drug Register is one of the largest pharmacoepidemiological databases in the world.

Scientific production in numbers

Number of articles, books, book chapters, reports, and PhD theses are reported below by research area.

Research area	Original articles	Review articles	Book chapters	Reports	PhD theses
A Longevity, morbidity, and functioning	39	4	-	-	1
B Treatment and care of elderly persons	51	5	-	-	2
C Health trends and inequality	23	1	-	-	2
D Brain aging	56	4	5	-	5
E Miscellaneous	13	-	-	4	-

Figure 1. Number of articles, books, book chapters, reports, and PhD theses reported by research area during 2015-2016..

Research – major findings in brief

A complete list of references cited in this section is provided in the appendix.

Research area A: Longevity, morbidity, and functioning

Challenging questions in aging research include the definition of healthy aging and the interplay between the multiple factors that contribute to health in older populations. Using large population-based studies, ARC researchers attempt to understand the complexity of health in older adults by investigating and monitoring health status during aging and by exploring various determinants of health, including genetic, biological, and environmental factors.

The social gradient

Despite continuing increases in longevity, it has become more and more evident that we have sharp, and in many cases increasing, differences in longevity and mortality risks by socioeconomic factors. This phenomenon is typically referred to as the social gradient (Fritzell, 2016). In a number of studies, we analyzed the relationship between income and mortality on the micro level of individuals and at the population level of countries. Our comparisons of rich countries suggest that relative poverty is important to mortality risk even after adjustment for a number of covariates (Fritzell et al. 2015). In a Nordic comparative project, we analyzed total population register data and found that the strength of the association between a household's disposable income and death risks up to five years later not only existed in all Nordic countries, but also had increased in all of them (Mortensen et al. 2016). This trend was evident at the same time as income inequality continued to grow.

Although the vast majority of all deaths occur in old age, surprisingly few studies have included older people in studies of the social gradient. In our Nordic comparison, we found that the income gradient in mortality also exists in older people: the difference in mortality risks between people with high and low income is profound, although it decreases in very old age (Mortensen et al. 2016). In a 19-year follow-up of a Swedish population cohort, we also found that late-life income was associated with mortality even after adjusting for income in midlife, which indicates that retirement income is important to health (Rehnberg & Fritzell, 2016).

Paths toward healthy aging

Lifestyle behaviors (such as smoking; mental, physical, or social inactivity); and a moderate or poor social network affect people's chances of survival. However, less is known about whether lifestyle modulates the effect of genetic background on mortality. Using data from the Kungsholmen project, we found an increased risk of mortality in people who carried certain variations in four genes that are related to cardiovascular diseases and metabolism. However, a healthy lifestyle (being a non-smoker; participating in physical, mental, and social activities; and having a moderate or rich social network) attenuated the negative effect of these genetic profiles. People with a healthy lifestyle had an approximately 64% lower mortality risk than those with poor lifestyle (two or more adverse lifestyle behaviors), independent of genetic profile (Rizzuto et al. 2016).

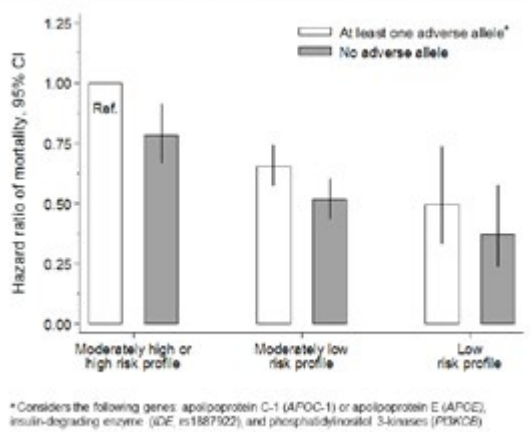


Figure 2. Association between mortality and the combination of genetic and behaviors risks. The values are expressed as hazard ratios (HRs) of mortality with 95% confidence intervals (CIs) adjusted for age, sex, education, BMI, dementia, ischemic heart- and cerebrovascular diseases, and diabetes (adapted from Rizzuto et al. 2016).

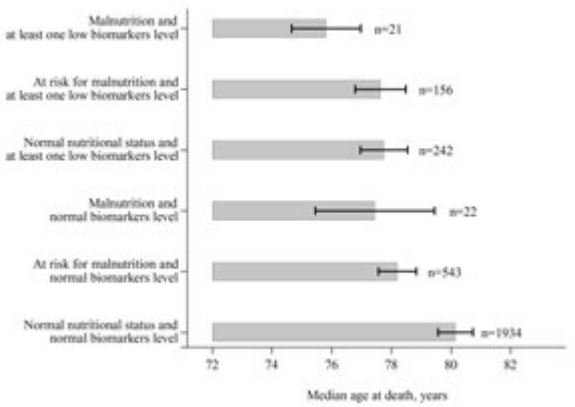


Figure 3. Median age at death in six groups according to combinations of nutritional status and biomarkers levels (adapted from Shakersain et al. 2016).

In another study, we used SNAC-K data to investigate the prevalence of poor nutritional status, including malnutrition and risk for malnutrition, and the association between poor nutritional status and survival. We also explored the role of relevant biomarkers (hemoglobin, albumin, and C-reactive protein) in this association. Less than 2% of all participants had malnutrition; 25% were at risk for malnutrition. Participants at risk for malnutrition died a median of 1.5 years earlier—and those who were malnourished, approximately 3 years earlier—than participants with normal nutritional status. Malnutrition or risk for malnutrition, together with abnormal biomarker (hemoglobin and albumin) levels, shortened survival by an additional year (Figure 3) (Shakersain et al. 2016).

We also investigated the association between alcohol consumption and survival in people who are very old. As in younger people, in those who are very old, abstinence and heavy alcohol use were associated with shorter survival than light to moderate drinking. Differences in health and physical function at baseline explained differences in survival to a large extent (Agahi et al. 2016).

Characterizing health in old age

Multimorbidity is one of the main challenges facing health systems worldwide. Although researchers generally concur that multimorbidity is "the simultaneous presence of two or more chronic diseases," they have not yet agreed on how to operationalize the concept. To help address this challenge, ARC researchers and their collaborators abroad developed a comprehensive list of chronic conditions that can be used to define and measure multimorbidity. An international team of physicians and epidemiologists that included ARC researchers used a consensus definition of chronic disease to classify diseases in the International Classification of Diseases 10th revision (ICD-10) as chronic or not chronic. They then grouped the diseases into broad categories that can be used to measure multimorbidity. Once validated, this operational measure of multimorbidity can be used in studies that might help lead to better care (Figure 4) (Calderón-Larrañaga et al. 2016).

We also explored the heterogeneity in the health of older adults by integrating number of chronic diseases, physical and cognitive performance, and personal and instrumental activities of daily living in a health assessment tool. Data for this project came from SNAC-K. Our results indicate that this integrated health assessment tool can identify age- and sex-specific health trajectories. The tool was a reliable and strong predictor of adverse health outcomes such as hospitalization and mortality. We found that more than 90% of the participants who were younger than 85 years were free of severe disability. Furthermore, around 50% could manage their daily activities independently, despite having chronic conditions. This study provided a positive picture of the health status of people aged 60+. The tool is potentially useful in clinical practice and public health interventions (Santoni et al. 2016).

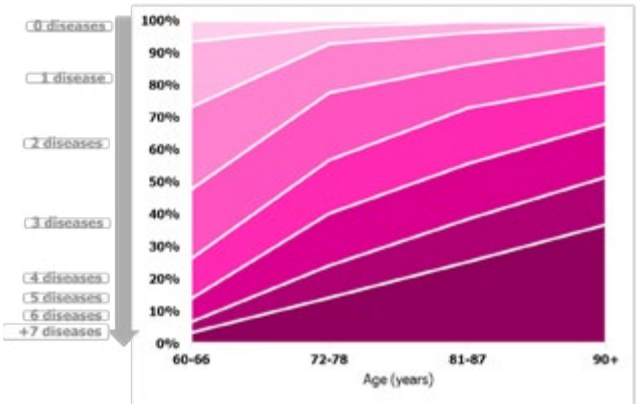


Figure 4. Distribution of number of chronic diseases by age groups in SNAC-K (adapted from Calderón-Larrañaga et al. 2016).

Midlife working conditions and late-life health

With the rapid growth of the older population, it has become more relevant to identify factors earlier in life that influence the varying patterns of function and health observed in older age groups. Most adults spend a considerable amount of time at work. Working conditions may therefore be an essential target for strategies to help people maintain their health into older adulthood. We found that work stressors in late midlife (age 57-65) were associated with limitations in late-life physical functioning (measured as self-reported mobility and tests of lung function and physical performance). However, women seem to be vulnerable to high strain jobs (high demands and low control) and men to passive jobs (low demands and low control) (Nilsen, Agahi & Kåreholt, 2016). These findings indicate that it is important to take the role of gender into account when studying work stressors in late midlife as predictors of physical functioning in old age.

We also analyzed the relationship between mortality and the combined effect of high job strain in midlife (age 42-65) and sense of coherence. We viewed a sense of coherence as a personal resource for coping with stress—those with a sense of coherence perceive life as meaningful, manageable, and comprehensible. In those with a weak sense of coherence, high job strain was associated with increased mortality; the associations were even stronger in women than men. The association between work stressors and mortality was not significant in those with a strong sense of coherence. These findings indicate that a strong sense of coherence may limit the negative effects of work stressors (Nilsen et al. 2016).

The environmental complexity hypothesis posits that an intellectually and socially engaging work environment leads to better health outcomes. Intellectual and social engagement at work is often operationalized as occupational complexity. We found that independent of socioeconomic position, greater occupational complexity in midlife was associated with less psychological distress in old age. One way to prevent psychological distress in old age may be to increase engagement at work in midlife (Darin-Mattsson et al. 2015). We also found that greater work complexity and greater participation in cognitive or social leisure activities in midlife was independently associated with better cognition in old age. Having had both greater work complexity and participation in leisure activities, or one of these at a level above average, was sufficient to increase the likelihood of better cognition in old age (Andel, Silverstein & Kåreholt, 2015).

Physical and mental function and health in old age

Previous research has shown that older people's physical function and mental function are strong markers of overall health status. We explored the ways a combination of physical and mental function is associated with various health outcomes. First, we investigated the associations between blood pressure and all-cause, cardiovascular, and non-cardiovascular mortality in older SNAC-K participants and explored whether chronological age and biological age modified the associations. In people who were biologically young (free of cognitive impairment and mobility limitation), low systolic blood pressure (<130mmHg) significantly decreased all-cause mortality and non-cardiovascular mortality. However, in biologically old people (with cognitive impairment or mobility limitation), low systolic blood pressure was associated with increased all-cause mortality and increased non-cardiovascular mortality. These findings suggest that biological age plays an important role in the association between blood pressure and all-cause mortality and between blood pressure and non-cardiovascular mortality (Liang et al. 2016).

In another study, we used SNAC-K data to investigate the association between cognitive and physical deficits and injurious falls and to examine whether the associations differed by follow-up time. Our results showed that deficits in processing speed and executive function were associated with an increased risk of injurious falls in the long term. By contrast, physical deficits such as impaired balance and walking speed predicted injurious falls in the short term, especially in people with global cognitive impairment (Figure 5; Welmer et al. 2016).

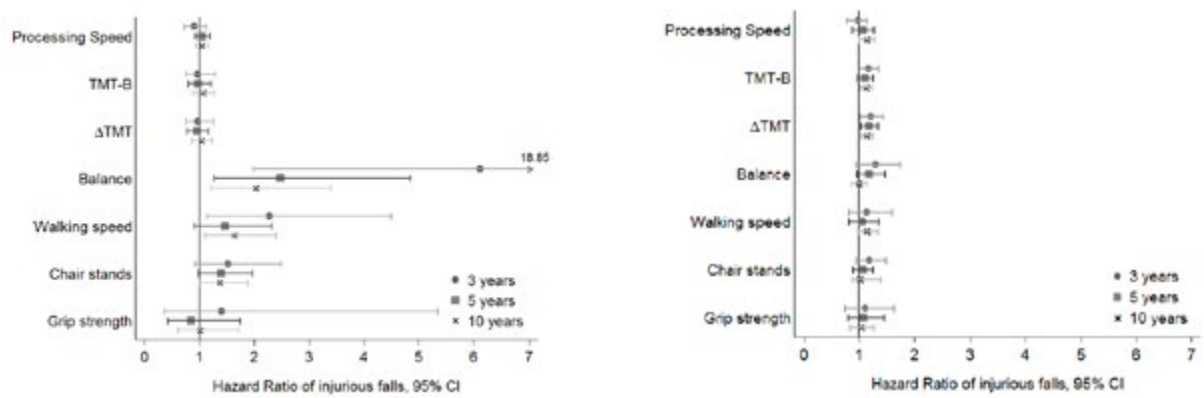


Figure 5. Hazard ratios with 95% confidence intervals for injurious falls over different lengths of follow-up derived from separate flexible parametric survival models for cognitive and physical functions: (A) in people with cognitive impairment and (B) in people without cognitive impairment. TMT = Trail Making Test, ΔTMT = time to complete TMT-B minus time to complete TMT-A. Standardized scores were used (1 unit represents 1 SD worse score) (adapted from Welmer et al. 2016).

Research area B: Treatment and care of older people

With our research in geriatric pharmacoepidemiology at ARC, we aim to understand and improve drug treatment in older people. This work focuses on the quality of older people's drug therapy, drug treatment in people with dementia, drug utilization at the end of life, and monitoring drug use over time. We develop analytical methods for studying drug use and for reviewing drug treatment in older patients. We also create technological solutions to help prescribers make optimal decisions. We collaborate closely with the Swedish National Board of Health and Welfare.

With regard to health and social care services for the older population, we focus on how people's care needs are met. We also investigate the social policy implications of increasing longevity and the increasing number of older people with ill health and complex health problems.

Quality of medication use in older adults

In a collaborative project that used data from the Swedish Dementia Registry, we found that use of antidepressant treatment prior to a dementia diagnosis is associated with a lower mortality rate, specifically in patients with Alzheimer's disease (Enache et al. 2015).

Polypharmacy, the concurrent use of five or more drugs, is becoming more common among older adults in Sweden (Wastesson et al. 2016a). In collaboration with researchers from the University of Southern Denmark, we found that a 65-year old Swede can expect to live another 20 years on average. Of these remaining years, eight will be lived with polypharmacy (Wastesson et al. 2016b).

In a collaborative project with researchers from France, we found that cancer patients with dementia were less likely to receive active treatments in their last month of life than those who had not been diagnosed with dementia (Morin et al. 2016a). Furthermore, we compiled data from international scientific studies to investigate how often drugs that should not be prescribed to older adults were actually used in nursing homes. We found that almost half of nursing home residents use potentially inappropriate medications, and such use has become more common over time (Morin et al. 2016b).

Health and social care services for older people

Between 1992 and 2014, there was a reduction in formal care for older people living at home. Women were more affected by this development than men, since they relied on formal care to a greater extent than men did. They were also less likely to have sources of informal care to fill the gap left by diminishing formal care. The most influential factor in care receipt was, however, living alone. Living alone was associated with both a greater likelihood of receiving formal care and a lower likelihood of receiving informal care (Dahlberg et al. 2016).

The downsizing of institutional care means that older people now move into an institution later in life, with poorer health and more disability. We found that the length of stay in institutional care has decreased in recent years and that the proportion of people who moved into institutional care and died shortly afterwards has increased rapidly (Figure 6; Schön et al. 2016).

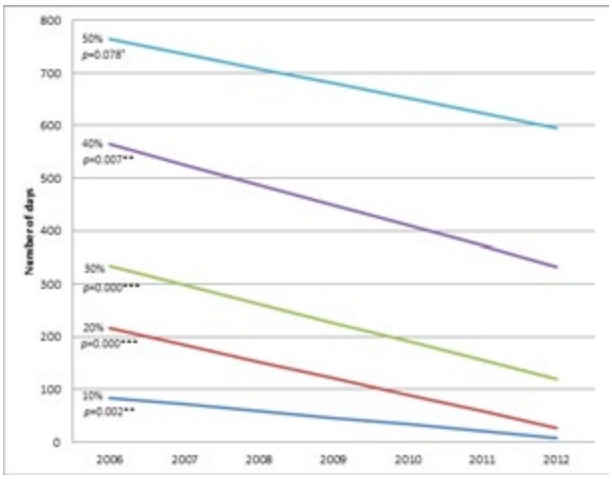


Figure 6. Length of stay in institutional care, measured as number of days from moving in until death, for the 10th to the 50th percentile for each year between 2006 and 2012, adjusted for age and sex. †p < .10; p < .01; ***p < .001 (adapted from Schön et al. 2016).

Research area C: Health trends and inequality

One crucial question that follows from the continued increase in old age life expectancy is the extent to which the extra years added to life are lived in poor or good health. That is, are we facing a compression or expansion of morbidity? Researchers at ARC study trends in health and function over time to address such questions. Moreover, the possibility of being in good health in old age is unequally distributed; for example, between men and women and between different socioeconomic groups. Inequalities between different subgroups of the population are also apparent in other living conditions (e.g., financial resources and social networks) that are central to well-being in later life. Such inequalities are the focus of several research projects conducted at ARC.

Trends in the health of the aging population

A key issue for ARC researchers is to investigate whether or not increases in life expectancy have been accompanied by decreases in the prevalence of health problems and disability. A recent study focused on this issue in China. Although the prevalence of disability in activities of daily living (ADL) has been decreasing over time in older Chinese adults, less is known about time trends in the incidence of ADL disability. By analyzing data from the China Health and Nutrition Survey, a nationally representative sample of people aged 60 years and older, we found that the incidence of ADL disability decreased from 1993 through 2006. The decreasing incidence was independent of sociodemographic, lifestyle, and chronic health conditions and especially evident in the ADL items transferring and bathing (Liang et al. 2016).

Gender inequalities in healthy life expectancy

A current research project is investigating whether changes in the amount of time lived in good or poor health at the end of life differ for men and women. We explored the change in health expectancy (proportion of life expectancy without health problems) at age 77 between 1992 and 2011 in Sweden by combining mortality data from Statistics Sweden with health data from SWEOLD and from the Survey of Health, Ageing and Retirement in Europe (SHARE). Using these data, we calculated life expectancy with and without mobility problems, with and without mild disability, and with and without severe disability. In general, our results indicate that for women, who had a smaller increase in life expectancy than men, the increase in life expectancy primarily consisted of years free from disability and mobility problems. For men, it seems that the increase in life expectancy primarily comprised years with functional limitations (Figure 7). Thus, it appears that between 1992 and 2011, the increase in women's life expectancy was accompanied by a compression of health problems, whereas the increase in men's life expectancy was accompanied by an expansion of health problems. Hence we see a convergence of the gender gaps in life expectancy and health expectancy (Sundberg et al. 2016).

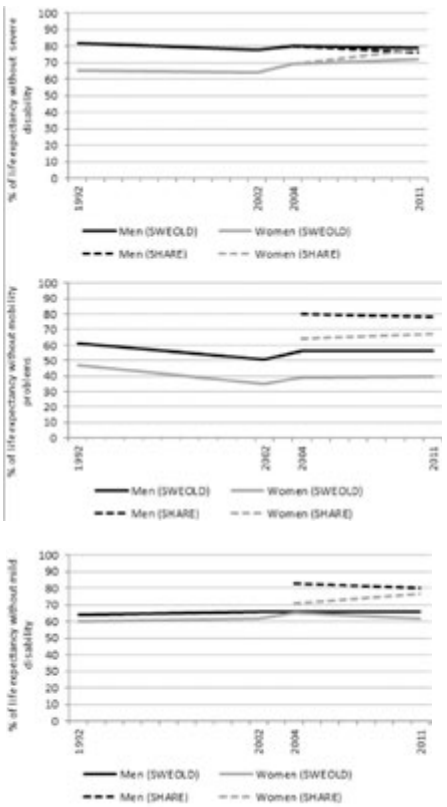


Figure 7. Estimated proportions of remaining life expectancy to be lived without severe disability, without mild disability, and without mobility problems (adapted from Sundberg et al.).

Gender differences in loneliness

A common understanding is that loneliness in old age is a more or less persistent condition. Contrary to this view, ARC researchers have shown that feelings of loneliness vary over time. In a study measuring loneliness at two points in time with a seven-year interval, it was found that almost half of those who at baseline reported that they frequently felt lonely did not report loneliness at follow-up (Dahlberg et al. 2015).

Feelings of loneliness are predictive of several different health outcomes and mortality in old age. Factors that may predict loneliness are however relatively underexplored. Using SWEOLD data, researchers at ARC have investigated the effect of various forms of social engagement on loneliness, with a follow-up time of 20 years. Social engagement was measured with marital status, social support, social contacts, social activity and religious activity. Most kinds of current social engagement were more strongly associated with loneliness in old age than social engagement 20 years earlier. However, previous patterns of social engagement were important in the sense that they were associated with patterns of social engagement in old age (Dahlberg et al. 2016).

Socioeconomic inequalities in late-life health and living conditions

In line with the literature, we have previously found considerable inequality in the health of older adults by gender and by socioeconomic status. Such disparities are evident in old-age across a wide range of different health indicators (Fors & Thorslund 2015), as well as in risks of dying (Fritzell 2016). In addition, we recently explored inequalities in the probability of experiencing several coexisting disadvantages, measured as physical health problems that coexist with problems in other life domains, such as limited financial resources and limited social networks. Using SWEOLD data, we found that coexisting disadvantages were more frequent in certain demographic and socioeconomic groups: being older, female, previously employed as a manual laborer, and currently not married were all associated with an increased probability of experiencing coexisting disadvantages (Heap et al. 2016).

One possible explanation for socioeconomic differences in late-life morbidity and mortality is that such differences can, at least in part, be caused by unhealthy lifestyle factors. Building on this research, we investigated whether social groups that are more disadvantaged are also more vulnerable to the effects of unhealthy behaviors. Differential vulnerability has been shown in other studies, particularly in relation to mortality. We analyzed the impact of smoking and physical inactivity on mobility impairment by level of education (high and low). Those with a low level of education experienced an earlier onset and a faster progression of mobility impairment during old age. However, we found no clear support for differential vulnerability as differences in the association between heavy smoking or physical inactivity and the progression of mobility impairment were not significant (Agahi et al. 2016).

People of low socioeconomic position tend to be less represented in both cross-sectional and longitudinal surveys of older people than people of high socioeconomic position. In a recent thesis (Kelfve, 2015), an ARC researcher showed that the sample selection that normally occurs in longitudinal samples, caused by higher mortality in those of low socioeconomic position, tends to be compounded by the lower response rates in people from these groups (Figure 8). She also showed that excluding the most disabled and frail people from a survey may not only result in underestimated poor health, but may also lead to an underestimation of the relative disadvantages people of low socioeconomic positions experience (Figure 9). Thus, although research has shown apparent socioeconomic differences in health and social disadvantage, these may still be underestimated because of survey design and non-response.

Figure 8. Changes in distribution of social class over time in the SWEOLD sample after mortality (M) and attrition (A). Women born 1924-1934 (adapted from Kelfve, 2015).

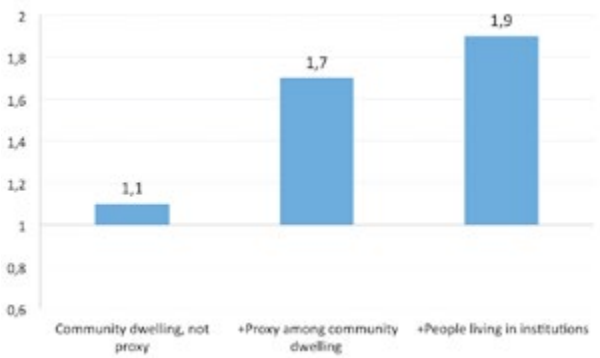


Figure 9. Relative risk of ADL limitations for low educated compared with high educated, by inclusion criteria (adapted from Kelfve, 2015).

Research area D: Brain aging

People's individual cognitive capabilities differ, and differences widen as people age. At ARC, we focus on understanding the reasons for these differences. Why do some 80-year-olds have better memory than 35-year-olds? Why do some people maintain a youthful brain but others develop dementia? How does behavior over the life course affect brain changes? Is it possible to slow, stop, or reverse cognitive decline by mental and/or physical training or changes in diet? Several factors typically interact to cause faster cognitive decline and dementia, and some factors can protect against cognitive deterioration.

Risk and protective factors for brain lesions, cognitive aging, and dementing disorders

Vascular burden. Vascular disorders and risk factors play an important role in the development of dementing disorders. Our center has a strong research team working on the role of vascular factors in brain aging. First, we examined the relationship between the CAIDE Dementia Risk Score and dementia-related brain changes visible on (MRI scans. We found that the score was associated with white matter hyperintensities, and over the longer term, with medial temporal lobe atrophy (Vuorinen et al. 2015). Second, we explored the underlying pathological mechanisms linking cardiovascular burden to cognitive decline and showed that mixed brain lesions mediate the effect of cardiovascular risk burden on cognitive deterioration (Figure 10; Wang et al. 2016). Finally, we summarized evidence about shared vascular risk factors, cognitive decline, and cardiovascular diseases and proposed strategies to promote cardiovascular health that might help delay the onset of dementing disorders (Qiu et al. 2015).

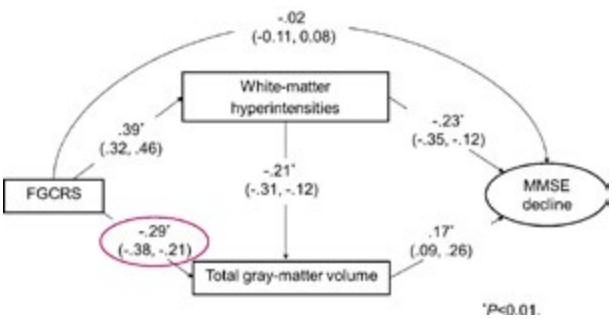


Figure 10. Mediating role of structural brain characteristics between vascular risk factor burden and cognitive decline (adapted from Wang et al. 2016).

Diabetes. Diabetes is associated with dementia risk, and our research aims to help identify the mechanisms that underlie this association. We found that diabetes may affect certain cognitive domains (perceptual speed, category fluency, and attention/primary memory) before other domains (Marseglia et al. 2016). Evidence shows that the link between type 2 diabetes and Alzheimer's disease may be influenced by variations in the *IDE/HHEX* gene region. We provided the first evidence that a variant in the *HHEX_23* gene may exacerbate the risk that diabetes confers of developing dementia and Alzheimer's disease (Figure 11). This variant was also associated with structural brain changes in older people who did not have dementia (Xu et al. 2015).

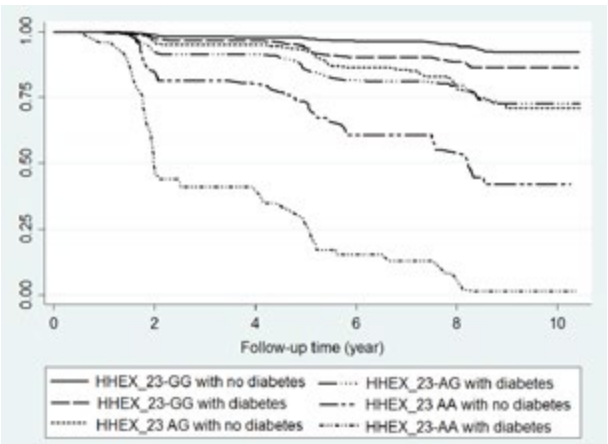


Figure 11. Kaplan–Meier survival estimates from baseline to dementia occurrence by diabetes (including prediabetes) and *HHEX_23* genotypes (adjusted for age, sex and education) (adapted from Xu et al. 2015)

Lifestyle factors (nutrients, diet, and physical activity). A growing body of research focuses on modifiable risk factors for brain aging, including nutrients, diet, and physical activity. First, we investigated the role of vitamin B12, folate, and sulfur amino acids in structural brain changes that precede clinical dementia. We found that higher blood levels of vitamin B12 and holotranscobalamin as well as lower homocysteine values were associated with a decreased rate of total brain tissue volume loss (Hooshmand et al. 2016). Second, as most people eat a combination of healthy and less healthy foods, we examined the impact of mixed dietary patterns on cognitive decline. We found that the prudent diet may buffer the risk for cognitive decline associated with the Western diet (Figure 12; Shakersain et al. 2016). Finally, data from the CAIDE study showed that physical activity may reduce dementia risk. Risk reduction was greatest in men, people who were overweight, and people who did not carry *APOE* ε4 (Tolppanen et al. 2015).

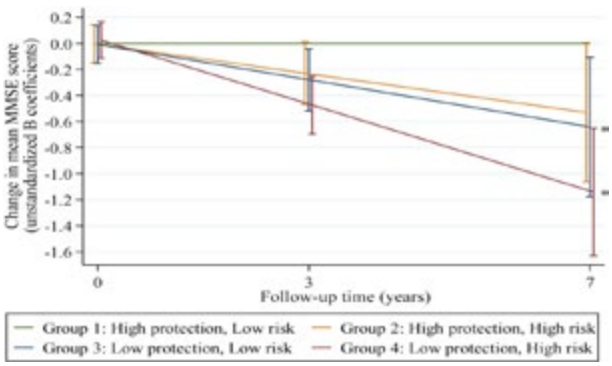


Figure 12. Changes in MMSE score over the 6-year follow-up by combined adherence to the Western and prudent dietary patterns. Group 1: High prudent and low Western diet ("high protection and low risk"). Group 2: High prudent and high Western diet ("high protection and high risk"). Group 3: Low prudent and low Western diet ("low protection and low risk"). Group 4: Low prudent and high Western diet ("low protection and high risk") (adapted from Shakersain et al 2016).

Human aging is characterized by chronic, low-grade inflammation in the body that has negative consequences for the brain and cognition. By contrast, a physically active lifestyle is associated positively with brain integrity, and studies suggest that physical activity may counteract the negative effects of inflammation. We therefore investigated the combined effects of self-reported physical activity and several blood markers of inflammation on brain integrity and cognition in 414 participants from SNAC-K.

Specifically, we examined whether an inactive lifestyle and high levels of inflammation resulted in smaller grey-matter volumes and predicted cognitive decline over 6 years in older adults. Self-reported physical activi-

ty (fitness-enhancing, health-enhancing, and inadequate) was linked to grey-matter volume such that individuals with inadequate physical activity had the least grey matter, a finding that replicated previous results of other studies. By contrast, we did not find any relationship between different pro- and anti-inflammatory markers and grey-matter integrity. However, physical activity interacted with the pro-inflammatory cytokine IL-12p40. People with inadequate activity and high levels of IL-12p40 had smaller grey-matter volumes in the prefrontal cortex and hippocampus than physically inactive people with low levels of IL-12p40 and more physically active people. In addition, these participants also declined more on a test of general cognition (MMSE) over 6 years (Figure 13).

Our study suggests that in older people, inflammation may worsen the negative effects of physical inactivity. Our data further suggest that IL-12p40, recently linked to Alzheimer's disease pathology in animal work, may be the most sensitive inflammation-related biomarker for detecting individual differences in brain integrity and cognitive decline in older adults in certain circumstances, such as when people are physically inactive (Papenberg et al. 2016).

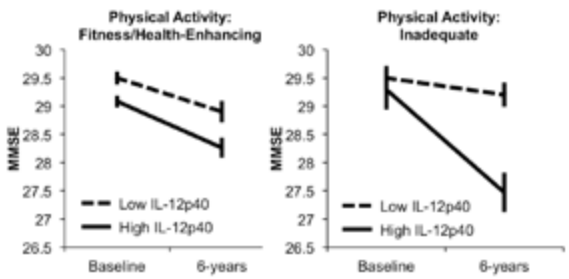


Figure 13. MMSE performance at baseline and 6-year follow-up as a function of physical activity and inflammation group. Error bars represent standard errors of the means (adapted from Papenberg et al. 2016).

Psychological stress. In the Finish CAIDE study, we found that midlife work-related stress increased the risk for MCI, dementia, and Alzheimer's disease after 21 years of follow-up. The association was not seen after 29 years of follow-up, which suggests that midlife stress is an important risk factor for dementia risk in late life (Sindi et al. 2016). In another study on the same population, we found that feelings of hopelessness in midlife, but not in late life, increased the risk of cognitive impairment in late life even after controlling for depressive feelings and for hopelessness in late life, which suggests that feelings of hopelessness in midlife may predict cognitive impairment later in life (Håkansson et al. 2015).

Prevalence and correlates of old-age olfactory deficits
Loss of olfactory function is common in old age and associated with poor health outcomes, such as dementia and mortality. In the following project, we investigated different aspects and correlates of olfactory performance that have rarely been studied before in the general older population.

In the first study (Larsson et al. 2016), we investigated whether it might be desirable to distinguish olfactory memory from episodic and semantic memory in old age. The results suggest that olfactory memory, measured as episodic odor recognition and odor identification, should be modeled separately from episodic and semantic memory for visual and verbal information (Figure 14). In a second study (Seubert et al. in press), we investigated the prevalence and correlates of olfactory dysfunction using an established clinical cut off. We found that the overall prevalence of olfactory dysfunction in people 60 years and older was 24.8%. The principal factors associated with an increased probability of olfactory dysfunction were advancing age and history of coronary heart disease, whereas female gender and more years of education were linked to a lower probability. The third study (Sjölund et al. in press) focused on more qualitative aspects of olfactory dysfunction, assessed through a standardized interview. Phantosmia (olfactory hallucinations) was defined as perceiving an odor in the absence of any stimuli in the surrounding environment

that could emit the odor, and prevalence was estimated to be 4.9%. Main correlates of phantosmia were female gender, carrying the met allele of the *BDNF* gene (codes for a protein related to neuronal plasticity and survival), higher vascular risk burden, and reporting qualitatively distorted smell sensations (parosmia). Overall, the results of this project indicate that the prevalence of olfactory deficits in the general older population is not negligible, as many people have these problems. Some findings worth highlighting were that olfactory memory seems especially sensitive to the effects of age and the *APOE* gene and that some factors beneficial to preserved olfactory function, such as female gender and the *BDNF* met allele, were associated with a higher probability of experiencing phantom smells.

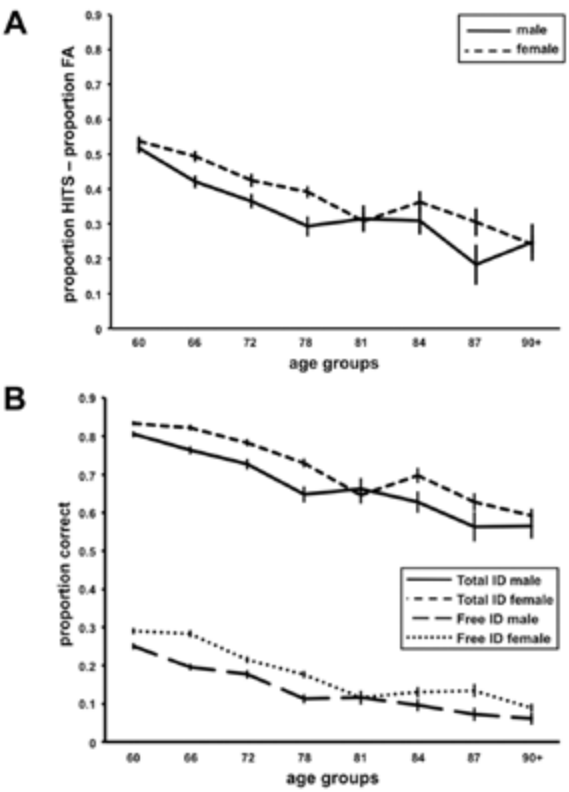


Figure 14. Means and standard errors for episodic odor recognition (hits - false alarms; A) and free and total (free + cued) odor identification (ID; B) as a function of age and gender (adapted from Larsson et al. 2016).

Preliminary results from the Cognition, Brain, and Aging project (COBRA - supported by a donation of af Jochnick Foundation)

Cognition, Brain, and Aging (COBRA) is a 10-year project with three measurement occasions separated by five years. COBRA represents a collaboration among ARC, the University of Umeå, and the Max Planck Institute in Berlin. The study sample (n = 183) ranged from 64-68 years of age at baseline. The assessment battery includes positron emission tomography (PET)-derived markers of dopamine (DA) D2 receptor binding, structural MRI (grey- and white-matter structure), functional MRI (networks activated during working memory and resting-state networks), perfusion, a comprehensive cognitive battery (episodic and working memory, speed, and implicit learning), a questionnaire targeting lifestyle activities (physical, mental, and social), and blood sampling for genetics and biomarkers.

The chief goal of COBRA is to relate age-related cognitive changes to changes in the brain parameters assessed. Of particular interest is to examine which of the candidate neural correlates of cognitive decline first displays signs of change in old age. Likewise, we aim to determine whether change in one brain variable is associated with subsequent changes in other brain measures and thus acts as a primary mechanism of age-related decline in brain and cognition. The extent to which the activity factors are associated with changes in the brain parameters is largely unknown. The first follow-up in the COBRA project commences in the fall of 2017. The future availability of longitudinal DA data will make COBRA unique in an international context.

Awaiting such data, we are analyzing cross-sectional associations between brain and cognition and how these links may be affected by lifestyles. Key findings from the first wave of assessment include that (a) the link between D2 binding in caudate and episodic memory is mediated through functional connectivity between ventral caudate and hippocampus; (b) self-rated intensity of physical activities is related to both D2 receptor availability in caudate and episodic memory performance; (c) D2

binding potential, as assessed with [11C] raclopride, is a valid indicator of D2 availability even in extrastriatal regions with very few receptors (limbic system, neocortex); (d) The retrosplenial cortex may serve as a gateway to memory by linking subcortical and cortical brain regions; (e) a subgroup of people potentially at risk for working-memory dysfunction show reduced functional and structural integrity and low D2 availability in the fronto-parietal network; and (f) for most people, high D2 availability comes with high cognitive performance and low availability with low performance. However, there is a smaller group where high D2 availability instead comes with poor cognitive performance. These individuals differ from the other individuals such that high D2 availability may be related to good performance only when the rest of the brain and the body is adapted to the high availability.

Otto Hahn Research Group on Associative Memory in Old Age

Older adults have specific difficulties in remembering associative information, such as combining a face and a name. This associative deficit might be one reason why older adults typically gain less from memory training than younger adults: such procedures often require the binding of two elements into a coherent representation. In addition to mean age differences, large inter-individual differences in binding performance have been observed in late life. The main research goal of this project is to further our knowledge on inter-individual differences in associative memory in old age. Why are some older adults quite good at remembering associative information while others are not?

Our first study investigated how brain structure; specifically, the volume of gray matter in various regions of the brain, was correlated with differences in the associative memory of a subsample of 60-year-old participants in SNAC-K. We asked participants to perform an item and associative recognition task following intentional learning. Specifically, they were to learn face-scene picture pairs and later recognize single pieces of information (a face or a scene) and face-scene pairs. To identify the structural correlates of associative memory, we controlled for item memory in all brain analyses. The results showed that participants' associative memory varied widely and that item and associative memory performance were independent of each other. Those who performed better on the associative memory task had larger gray matter volume, mainly in one specific brain region, the left dorsolateral prefrontal cortex (Brodmann area 8; Figure 15). Thus, the left dorsolateral prefrontal cortex seems to be important in intentionally learning associations. Research has shown that the prefrontal cortex is associated with organizational and strategic processes in memory formation. The difference between older adults with good and poor associative memory functioning seems to be related to differences in these processes. This is the first study to investigate how volumetric differences in the prefrontal cortex contribute to individual differences in associative memory in older adults (Becker et al. 2015).

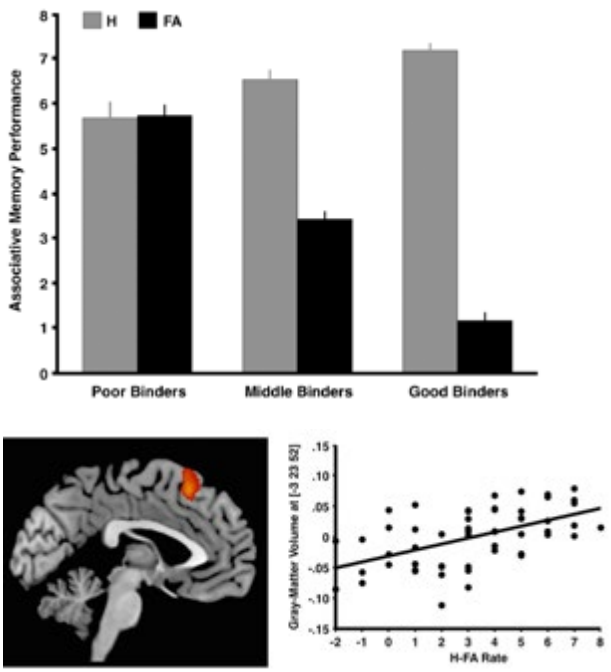


Figure 15. Above panel: Hit (H) and false-alarm (FA) rates in the associative-memory task across group (poor binders, middle binders, good binders). Error bars represent standard errors around the means. Below panel: Gray-matter volume correlates of associative-memory performance in left dorsolateral prefrontal cortex (BA 8) (adapted from Becker et al. 2017). BA = Brodmann area.

In a second study, we investigated the impact of intentional and incidental encoding instructions on item and associative memory. Additionally, we looked at the differences in brain function associated with either intentional or incidental item and associative memory encoding. During functional MRI, participants saw combinations of two or three objects or a single object cut into two or three pieces (to keep visual input comparable). Some were given intentional encoding instruction. Specifically, they were told that they would later need to remember the pair of objects, the trio of objects, and the single objects. Others were given incidental encoding instruction; these participants were asked to identify the objects as animate or inanimate.

In line with the findings reported in previous studies, participants given the intentional instructions had higher total memory performance than those given the incidental ones. Memory performance was better for single items than associations regardless of encoding instructions. In those instructed to intentionally remember, we observed greater activation in the left anterior hippocampus than in those given incidental instructions, but only for remembering associated objects, not for remembering single objects. Moreover, in intentional learning, we observed greater activity in the left anterior hippocampus and left inferior frontal gyrus when people were remembering associations than when they were remembering single objects.

For intentionally encoded associations, we studied subsequent memory effects (i.e., comparing brain activity for those associations later remembered with those later forgotten). We observed greater activation of the same brain regions as in the previous analyses (namely, the left anterior hippocampus and left inferior frontal gyrus) for intentionally encoded associations that were remembered than for those that were forgotten. This means that these regions are relevant to the task of remembering associations. Additionally, connectivity analyses showed that the anterior hippocampus is uniquely linked to the right superior temporal lobe and inferior frontal gyrus in subsequent memory of associations that are intentionally learned. The intent to remember thus may activate a specific binding process in the anterior hippocampus. This is suggested by our finding that the anterior hippocampus is activated differently in incidental than in intentional associative encoding (Figure 16; Becker et al. 2017).

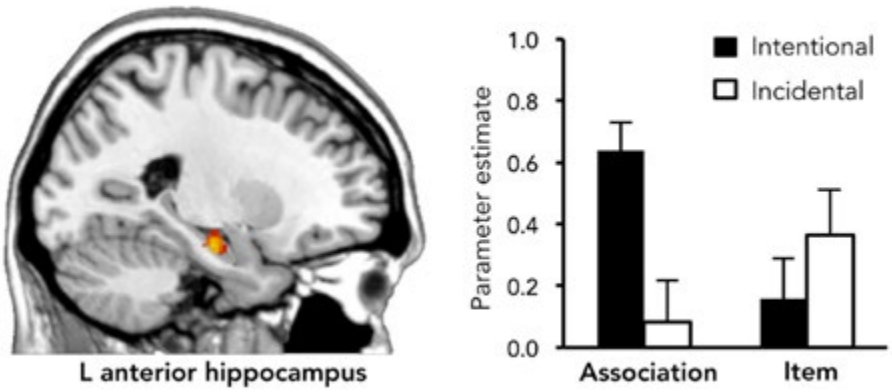


Figure 16. Region in the left anterior hippocampus showing a significant task-by- instruction interaction indicating the role of the left anterior hippocampus when intentionally encoding associations, but not when incidentally encoding associations or encoding single items under either instruction type. Mean subject-specific weights of voxels within this region are plotted separately for encoding groups and experimental conditions. Error bars represent standard errors around the means (adapted from Becker et al. 2017).

Our third study investigated the link between disadvantageous genetic predispositions and associative memory deficits in older people. Specifically, because previous research shows that dopaminergic modulation in animals and humans is important in binding associations, we used data from the SNAC-K study to examine the importance of DA receptor genes in remembering associations and items. We combined the effects of single nucleotide polymorphisms of DA D1 (DRD1; rs4532), D2 (DRD2/ANKK1/Taq1A; rs1800497), and D3 (DRD3/Ser9Gly, rs6280) receptor genes into a single genetic score and investigated the effects of this genetic score. Older adults with alleles that are associated with greater DA receptor efficacy (DRD1 C allele; DRD2 A2 allele; DRD3 T allele) performed better on an associative memory task than those with less DA receptor efficacy (Figure 17; Papenberg et al. 2017).

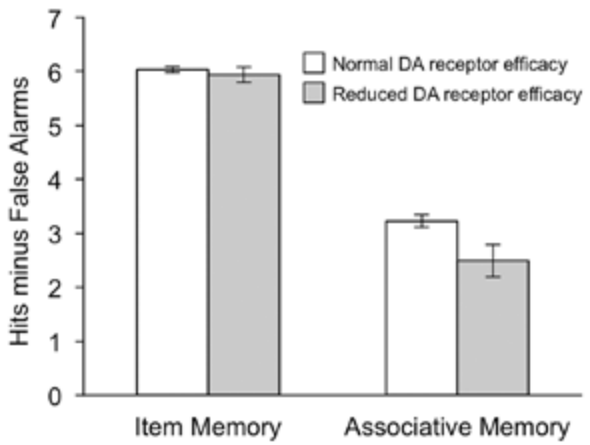


Figure 17. Item and associative memory performance for carriers of genetic predispositions for normal and reduced dopamine (DA) receptor efficacy (adapted from Papenberg et al. 2017).

The *Otto Hahn Research Group on Associative Memory in Old Age*, funded by the Max Planck Society (Germany), was established at the Max Planck Institute for Human Development (Berlin, Germany) in December 2012. It is located at the Aging Research Center.

Education

Courses

Undergraduate (first cycle) courses

ARC researchers are responsible for and involved in three courses that are part of the psychology program at KI. "Society and health" (led by Neda Agahi) has an epidemiological and a sociological perspective and gives the students the opportunity to learn about health inequalities in different contexts.

The aging section of the "Developmental psychology" course, is led by Yvonne Brehmer. This section focusses on cognitive, emotional, and biological underpinnings of successful and pathological aging from the psychological and medical perspectives.

In the "Cognitive processes" course, researchers from ARC conduct lectures and seminars that cover different aspects of cognition and its neural base. The statistics section (co-led by Erika Jonsson Laukka) includes lectures and practical exercises on how to analyze behavioral data (in particular analysis of variance).

Master's (second cycle) courses

ARC researchers are responsible for and involved in several courses and supervise master's projects. Neda Agahi and Stefan Fors lead the course "Society, ageing and health" in the master's program "Population health: societal and individual perspectives" at SU. The course takes place every second year. The focus of the course is on health, health inequalities, and health development in older adults, including the interplay of mortality and morbidity and changes over time in this relationship. Using a life-course perspective, the course shows how conditions and experiences throughout life may contribute to health and health inequalities later in life.

ARC is also responsible for the course "Geriatric epidemiology" (led by Chengxuan Qiu and Anna-Karin Welmer) in the master's program in public health epidemiology at KI. The aim of the course is to provide an overall picture of worldwide population aging and the opportunities and challenges it poses. The course also illustrates the application of modern epidemiological approaches to studying the most common health problems in aging and to critically evaluating the epidemiological literature in aging research.

Doctoral (third cycle) courses

The doctoral course "Integration of neuroimaging and cognition in normal aging and dementia," led by Grégoria Kalpouzos and co-led by Francesca Mangialasche and Alireza Salami is part of the neuroscience program at KI. The purpose of the course is to provide methodological tools to link neuroimaging data to cognitive performance and interpret such relationships in the field of normal and pathological aging.

Researchers at ARC have also held the doctoral-level course "Application of epidemiological methods in ageing research" led by Barbara Caracciolo, Debora Rizzuto and Laura Fratiglioni. The course offers the opportunity to learn epidemiological methods and their applications to research on aging. Different epidemiological methods are presented, and after the course, the students understand the importance of epidemiological approaches in research on aging and health and have an updated understanding of the epidemiology of common geriatric disorders such as Alzheimer's disease and Parkinson's disease.

Swedish National Graduate School for Competitive Science on Ageing and Health (SWEAH)

Moreover, Kimberly Kane, scientific editor at ARC, has co-led the course "Scientific writing in quantitative aging research" for doctoral students. In the course, students learn to apply basic principles of writing to compose clear, concise, reader-centered scientific texts; identify the main messages in studies and use the main message and the basic principles of writing to outline articles; and identify and correct common problems in scientific writing, such as plagiarism, problems with verb tense, and ambiguity.

Since fall 2014, ARC, has collaborated in SWEAH. The overarching long-term goal of SWEAH is to develop and strengthen the recruitment base of future leaders in research on aging and health. SWEAH will achieve this aim by creating a sustainable multi- and cross-disciplinary national graduate school for competitive science that will ultimately lead to improved quality of life, health, medical treatment, and care for our aging population. In 2016, around 15 students at ARC were affiliated with SWEAH.

Photo: Maria Yohuang

Graduate Research School on Health and Aging

The graduate research school, funded by Forte, started in 2008 and ended in 2015. The idea behind the graduate school was to use the partners' respective competencies as the basis for a graduate school in aging research at a national level with substantial multidisciplinary interaction. The goal was to cover the different scientific disciplines related to older people both from a theoretical and a methodological point of view. In this way, the school sought to provide PhD students with the opportunity to access various courses and other educational activities in multiple scientific areas, giving them the advantage of a multidisciplinary perspective during their development as researchers.

The school offered courses (see above), seminars, workshops, and international forums to doctoral students in aging research in Sweden. A 1-hour weekly scientific seminar was also a regular event in the graduate school. The seminar program was prepared at the beginning of each semester. Both senior researchers and PhD students lectured at the seminars, providing opportunities for the students to engage in scientific discussions across disciplines and to form contacts with outside researchers that could lead to future collaboration. The number of seminars varied between 20 and 30 a year. These seminars will continue even though the graduate school is no longer running.

ARC has also hosted several senior researchers who are internationally recognized as authorities in their field. Each researcher has presented his or her major findings, opinions, and future perspectives in a 2-hour meeting (international forum) open to all students and other researchers at KI. Fourteen forums were held during 2015 and 2016. These are listed in the appendix. These forums will continue even though the graduate school is no longer running.

ARC had over 20 doctoral students during 2015 and 2016. Two doctoral students were registered at SU and defended their theses in 2015 and 2016. All other students were registered at NVS, KI, and eight defended their theses during the period.

Photo: Johanna Bylund

ARC Juniors – annual research retreat 2016 at Näsby slott.

PhD theses defended in 2015 and 2016

ALEXANDRA PANTZAR

Cognitive performance in old-age depression

Depression is especially distressful in older age, when added to diseases and physical disabilities, as well as vulnerabilities associated with an aging brain. Cognitive deficits in people with depression are associated with a poor prognosis and further complicate management of daily life. In the light of this background, this thesis investigated factors that potentially contribute to high variability of observed cognitive deficits and their reversibility in dementia-free nondepressed and depressed participants from the SNAC-K study.

The main findings showed that depression severity, disadvantageous alleles of memory-related genes, and psychiatric history influenced cognitive deficits (processing speed, attention, executive function, verbal fluency, episodic memory) in unipolar depression (no deficits were observed in semantic memory, short-term memory, or spatial ability). In addition, several factors acted as modulators: cumulative inpatient days, prodromal dementia, comorbidity of psychiatric disorders and heart disease, physical inactivity, and benzodiazepine drug intake. Longitudinal patterns of cognitive deficits in depression states (depressed-remitted, remitted-depressed, nondepressed-depressed) showed that some deficits may be reversible upon longer time spent in remission. Taken together, these findings indicate that cognitive deficits in depression should be regarded as treatment targets rather than as stable vulnerabilities.

Photo: Maria Yohuang

Alexandra Pantzar is now working as a postdoc at the Swedish School of Sport and Health Sciences (GIH).

ANDERS SKÖLDUNGER

Dementia and use of drugs: Economic modelling and population-based studies

Anders Sköldunger's thesis aimed to investigate epidemiological and health economic aspects of dementia and drug use in older people through economic modeling and analyses of population-based studies. Sköldunger used data from the two sites of Nordanstig and Kungsholmen in the Swedish National Study on Aging and Care (SNAC) to investigate the use of drugs in population of people 60 years and over and epidemiological studies on incidence and prevalence of dementia and mild cognitive impairment to populate the economic models. The results indicated that the cost of drugs used in the nervous system was five times higher in people with dementia than in people without dementia and that people with dementia had an elevated risk of hospitalization due to inappropriate drug use. The simulation studies showed that the main driver of cost in people with dementia, even those with mild dementia, was institutional care. Furthermore, a model that tested a hypothetical drug that modifies the disease found that the drug would not save society money, since it prolongs survival. However, the drug may be considered cost-effective if society is willing to pay 600,000 SEK per Quality Adjusted Life Year.

Anders Sköldunger is now working as postdoc at Umeå University on innovative housing models for older people and at KI on timely care for people with dementia.

Photo: Ellen Sköldunger

BEHNAZ SHAKERSAIN

Impact of nutritional status and diet on cognitive decline and survival

Nutrition has long been considered critical to promoting healthy aging. Behnaz Shakersain's thesis mainly focused on the relationship between overall nutritional status and survival and the complexity of associations between different eating patterns and cognitive decline in Swedish older adults. Compromised nutritional status in old age may significantly shorten survival, especially in those with suboptimal levels of biomarkers that reflect the severity of morbidity (i.e., hemoglobin and albumin). Assessment of these biomarkers in nutritional screening is recommended for better prioritization of people in need of nutritional interventions. Although high adherence to the Western diet is associated with accelerated cognitive decline, adhering more to the prudent eating pattern may diminish these effects. The newly proposed Nordic Prudent Dietary Pattern (NPDP) index may predict better preserved cognitive function in Nordic countries than adherence to other healthy dietary indices. These findings lend further weight to the growing evidence of a link between a healthy diet and healthy brain aging. Finally, an active lifestyle (being regularly engaged in physical, mental, and social activities) may reinforce the protective effect of a healthy diet (i.e., NPDP) against cognitive decline.

Behnaz Shakersain is now working as a researcher at ARC.

Photo: Private

JOAKIM SVÄRD

Emotional facial processing in younger and older adults

There is evidence that older adults have difficulty processing negative but not positive facial expressions. This positivity effect among older adults is expressed in attention to as well as in memory and recognition of emotional faces. In the present thesis, effects of stimulus properties (i.e., self-ratings of valence, arousal, and potency), context, and visual exploration were investigated. In Study I, two recognition tasks showed that happy faces were better recognized than fearful and neutral faces. Study II demonstrated that older adults perceived less arousal, potency, and valence than younger adults and that these differences were more pronounced for angry than happy faces. This was mirrored in larger age differences in attention, memory, and categorical perception for angry than happy faces. The results of Study III showed that older adult were more reliant on linguistic context than younger adults. Older and younger adults' visual exploration patterns were investigated in Study IV. The results showed that older adults spent proportionally more time attending to the mouth than to the eyes, which might explain their relatively lower recognition of fear, anger, and sadness but maintained happiness and disgust recognition. In sum, subjective impression (i.e., arousal, potency), context, and visual exploration patterns interact with adult age and should be considered in research on effects of aging on facial expression processing.

Joakim Svärd is now working as a statistician at the Health and care administration in Eskilstuna municipality.

Photo: Private

JOSEPHINE HEAP

Living conditions in old age: Coexisting disadvantages across life domains

Older age is associated with health problems but may also be associated with disadvantage in other life domains, such as limited financial resources and limited social networks. Moreover, the probability of experiencing simultaneous disadvantages in several life domains – coexisting disadvantages – is generally higher in older age. The overall aim of Josephine Heap's thesis was to analyze coexisting disadvantages in the older Swedish population. The analyses were based on data from two Swedish nationally representative surveys: the Level of Living Survey and the SWEOLD. The results showed that coexisting disadvantages in the older population were associated with specific demographic and socioeconomic groups. Physical health problems and mental health problems were central to the accumulation and coexistence of disadvantages in old age. People who experience coexisting disadvantages are likely to have a hampered ability to manage daily life. These people may need support from several different welfare service providers, and concerted actions may also be required. The results of this thesis may provide a basis for setting political priorities and making policy decisions.

Josephine Heap is now working as a scientific coordinator at ARC.

Photo: Tove Johnson

KRISTER HÅKANSSON

The role of socio-emotional factors for cognitive health in later life

This dissertation is mainly about social conditions in midlife and how they are associated with cognitive health in later life. The results were based on a large population-based study in Finland with a follow-up time of over 20 years.

The most important results suggest that living alone in midlife is associated with increased risk of dementia decades later, but also that the reason for living alone matters: those who had lost their partner relatively early in life had a much larger risk increase than people who were never married. A possible interpretation is that emotional factors related to the loss of a partner may have a role in explaining the association. When we checked this hypothesis further, we found that hopelessness in midlife increased dementia risk independently of marital status, whereas feelings of loneliness only mattered for people who in addition lived alone.

Krister Håkansson is now working as a researcher at NVS, KI, and as a psychology lecturer at Linnaeus University in Sweden.

Photo: Yanan Li

MARTIN BELLANDER

Plasticity of memory functioning: genetic predictors and brain changes

Human cognitive functions are not determined from birth but are plastic and can be altered by environmental factors. The promising idea of a cognitive intervention that would improve memory functioning has attracted a lot of attention over the last decades. Researchers have studied the improvement in a range of cognitive functions as a result of repeated memory training. This research has shown that people do not profit equally from training regimes, and that the effect on brain integrity also differs between people. This thesis explored factors related to individual differences in response to cognitive training administering cognitive training to healthy adults in a range of studies. Neural, behavioral, cognitive, and genetic measures and their relationship to the effect of training were then assessed. The results showed that the variability in training gains is not only noise, but rather meaningful variation that could be used to further our understanding of what factors determine the capacity for plastic change, both in brain and in behavior.

Martin Bellander is completing the training to become a licensed psychologist at the psychiatric clinic, Karolinska University Hospital.

Photo: Maria Yohuang

RUI WANG

Cardiovascular risk factors, brain structure, and cognitive decline in old age: a population-based study

Rui Wang's thesis investigated the burden of cardiovascular risk factors (e.g., diabetes, hypertension, high cholesterol, and obesity) among older adults (age ≥60 years) living in central Stockholm, and the associations between these risk factors and 1) structural brain characteristics and 2) cognitive decline in aging, taking genetic background (*APOE* gene) into account. All studies in her thesis used data from SNAC-K and the embedded SNACK MRI study. Findings from Rui's thesis suggest that cardiovascular risk factors and clusters of such factors are common in older adults and that higher cardiovascular risk burden accelerates the rate of global cognitive decline. The association between cardiovascular burden and cognitive decline may reflect the harmful effects of cardiovascular risk burden on pathological brain aging, including microvascular lesions, atrophy, and reduced microstructural white-matter integrity. Carrying the *APOE ε4* allele reinforces the adverse effect of cardiovascular risk burden on structural brain alterations and cognitive decline in aging.

Rui Wang is now working as a postdoc at ARC.

Photo: Johanna Bylund

SUSANNE KELFVE

Gotta survey somebody—methodological challenges in population studies of older people

Population surveys are one important tool for investigating health and living conditions among people in a society. This thesis aimed to analyze a) the characteristics of individuals at risk of being underrepresented in surveys of older people, b) the systematic errors likely to occur as a result of this selection, and c) whether these systematic errors can be minimized by weighting adjustments. In summary, the results show that people in the oldest age groups, women, those of low socioeconomic position, and those with the poorest health tend to be underrepresented in surveys of older people. This systematic underrepresentation might lead to an underestimation of poor health and function, a bias that is unlikely to be corrected by weighting adjustments, and to an underestimation of health inequality between educational groups. The results also show that the selective mortality that occurs in longitudinal samples might be compounded by selective non-participation among the most disadvantaged groups.

Susanne Kelfve is now working as a postdoc at Linköping University, Department of Social and Welfare Studies, Division Ageing and Social Change.

Photo: Johanna Bylund

ÅSA CRAFTMAN

Medicine management in municipal home care: delegating, administrating and receiving

Åsa Gransjön Craftman's thesis aimed to investigate how delegation of medication is handled in municipal home care. Specific aims were to explore the prevalence of medication use in older adults over time, describe district nurses' experiences of the delegation of medication management to municipal home care personnel, explore and describe how home care assistants experience receiving the actual delegation of the responsibility of medication administration, and describe how older adults living at home perceive receiving assistance from home care aids in managing their own medication. The results of the thesis showed a dramatic increase in medication use in older adults from the late 1980s to the 2000s in central Stockholm, Sweden. We found that district nurses cannot manage their workload without delegating the administration of medication to unlicensed personnel (home care aides) in the present organizational model of health and social care, that accepting the delegated responsibility to administer medication was inevitable and had become routine to meet the needs of a growing number of older home care recipients, and that assistance with handling medication eases daily life and medicine regimen adherence for older people. The results also showed that dependence on assistance may affect older adults' sense of autonomy and that perceived safety varied in a way that was related to home care aides' knowledge of medicine

Åsa Gransjön Craftman is now working as a Senior Lecturer at Sophiahemmet University, Stockholm.

Photo: Joakim Lehnström

Additional achievements

Career advancements: new positions/titles

Professors

- Kristina Johnell, Professor in geriatric pharmacoepidemiology
- Ingemar Kåreholt, Professor in gerontology at Jönköping University, associated with ARC
- Hui-Xin Wang, Professor in epidemiology at SU, associated with ARC
- Miia Kivipelto, Professor in clinical geriatrics at KI (Stockholm Sjukhem's professorial chair in clinical geriatrics) from June 1, 2016, associated with ARC

Associate professors

Stefan Fors, Associate Professor in Public Health Sciences at SU

Research associates

Stefan Fors
Benjamin Garzón
Goran Papenberg
Alireza Salami

New appointments at KI

- Erika Jonsson Laukka appointed new deputy director of doctoral education at NVS starting January 1, 2016.
- Anna Marseglia, chair of the NVS Doctoral Student Council from December 1, 2015.
- Debora Rizzuto, representing all postdocs at NVS in the NVS Department Council.
- Kristina Johnell, vice/acting head of department at NVS from January 1, 2015.
- Shireen Sindi, an equal treatment representative at NVS.
- Laura Fratiglioni, steering committee member of KI EIT Health.

Photo: Erik Cronberg

Kristina Johnell at the Karolinska Institutet's professors installation ceremony 2016 (fourth person from the left).

Appointments to commissions of trust outside KI

ARC researchers were appointed to different commissions of trust outside of KI, as for example: members of the Ethical Review Board; acted as peer reviewers for international and national funding agencies, including the Swedish Research Council; participated in scientific advisory boards, committees, boards and several EU networks and consortia; and served as invited lecturers and chairs of several national and international conferences.

Awards

- Miia Kivipelto received Alzheimerfonden's award for excellent research.
- Anna-Karin Welmer was awarded the Karolina Prize (*Karolinapriset*; the Karolinska Hospital research prize).
- Miia Kivipelto was awarded the Waijlit and Eric Forsgren's prize for distinguished Alzheimer's Researchers 2015.
- Bengt Winblad has been awarded jubilee prize from *Hjärnfonden*.
- Miia Kivipelto received the 2016 MetLife Foundation Award at the Alzheimer's Association International Conference (AAIC) in Toronto.
- Miia Kivipelto was named one of five Wallenberg Clinical Scholars in 2016.
- Lars Bäckman was awarded an honorary doctorate by Saarland University, Saarbrücken, Germany.
- Bengt Winblad received an Alzheimer's Association Lifetime Achievement Award in 2016.

Photo: Anna Larsson

Anna-Karin Welmer receiving *Karolinapriset*.

Photo: Alzheimer's Association

Bengt Winblad receiving the Alzheimer's Association's Lifetime Achievement Award in Alzheimer's Disease Research.

Outreach activities

Outreach activities

The aim of ARC's outreach activities is to share knowledge, promote understanding and awareness of aging research in the public domain. In this chapter we recount the communication dissemination from ARC which is done with the aim of informing the public, policy makers and the society at large, as well as influencing the clinical best practices in areas related to ARC's research.

Photo: Yanan Li

Audience at the House of Aging Research Open House on October 27, 2016.

Societal and clinical impact

Societal impact

ARC aims to impact society through a variety of activities and to inform stakeholders about the results of our research by participating in the public arena about issues relevant to aging research. During 2015 and 2016, ARC researchers frequently took part in national news programs on television and radio, including on the educational radio station (UR) and popular morning breakfast shows.

There is an increase in demand for lecturing, teaching, and participating in conferences, including outside academia. As well as informing local and county councils and pensioners' organizations, we participated in *Almedalsveckan* (an important week-long Swedish political forum).

ARC researchers had leading roles in several activities organized by Forte in their main outreach activity Forte talks.

Photo: Johanna Bylund

Scientific talk by Pär Schön, research associate, at the Forte talks.

ARC has been involved in organizing several symposia. ARC researchers participate in numerous research networks and have an extensive network of collaborators both nationally and internationally. ARC researchers are also involved in many teaching activities, such as seminars, international forums, and journal club meetings.

Photo: Annette Andersson

Dominika Seblova, PhD student, presenting her poster at the Forte talks.

Photo: Johanna Bylund

Laura Fratiglioni and Johan Fritzell in panel discussion with Annika Strandhäll, Minister for Social Security, Allan Larsson, Special Adviser for the European Pillar of Social Rights, and Kristina Tallberg, chair of PRO, during the PRO Global seminar in September 2016.

Our collaborators at the Stockholm Gerontology Research Center and Swedish Dementia Centre have established systems for reaching audiences outside the scientific community. Many of the researchers at ARC participate regularly in conferences and courses for care providers, politicians, other decision makers, and interest groups. ARC contributes to the Swedish-language magazine *Äldre i Centrum*, based at the Stockholm Gerontology Research Center. This national magazine on aging research covers health and disease in aging, presenting important happenings in the field.

Several ARC researchers took part in *Almedalsveckan* in 2015 and 2016; *Almedalsveckan* is an annual forum in Sweden for politicians from all the major political parties. ARC researchers have also hosted visits from national and international politicians and policy makers, including delegations from Chile, China, Denmark, and South Africa. During a visit by representatives of the parliamentary Committee on Health and Welfare to ARC in fall 2015, and during a visit to the Ministry of Health and Social Affairs, ARC underscored the importance of aging research in Sweden and worldwide.

A good example of societal attention and impact is within one of ARC's research projects in which it was found that the length of stay in institutional care has decreased in recent years, with a rapid increase in the proportion of people who moved into institutional care and died shortly afterwards. Two groups could be discerned among those who move in regard to health: those with physically very poor health, who die within a short length of stay, and persons with dementia who have a longer length of stay. These results have received a lot of attention, both in media and among politicians and policymakers, and has become widely spread.

As a higher proportion of persons die shortly after moving into institutional care, this means that more and more people are in the terminal phase of life when they move. This suggests a need for hospice-oriented institutions, with high medical competence to meet the needs of very frail older person in their final stage of life, and may be seen as a natural part of the aging in place policy.

Photo: Johanna Bylund

Visit to ARC from the parliamentary Committee on Health and Welfare.


En myt att kvinnor söker för allt möjligt
– Kvinnor är sjukare än män under hela livet och ändå lever de längre. Det brukar kallas för könsparadoxen.
Träning förbättrar minnet hos äldre
Pensionärer vill klara sig själva
Kommunens uppsökande verksamhet visar att mycket få av Alvestas 75-åringar vill ha något stöd från omsorgen. Forskarna anser att de borde vända sig till en ännu äldre målgrupp.
Kan man förebygga, lindra eller bota demenssjukdom?
Vi kan inte blunda längre
Nyheter
Gamla dör snabbt
För det första bor många hemma längre och när de väl kommer till äldreboendet är de sjukare och skörare. Monica Hillring, områdeschef på Skottsundsbacken.
Avhandling: Färre patienter läggs in vid platsbrist på sjukhusen
Många äldre vågar inte g
på kvällen
Män på Norrmalm lever fyra år längre än män i Farsta. I Sundbyberg vågar var tredje kvinna över 65 inte gå ut på kvällarna. I Rinkeby-Kista känner sig över 16 procent av de äldre ensam-
8 NYHETER
Ny studie förändrar hiv-historien
Äldres besök på a
Akutmottagning
Hemköpchef betalar inte
Nu är flera hyror klara
Många unga utan jobb
får olämpliga läkemedel
HÄR FÅR ÄLDRE MEST OLÄMPLIGA LÄKEMEDEL
1. Västra Götaland 9,64
2. Halland 9,20
3. Stockholm 9,09
4. Blekinge 9,09
5. Region Östergötland 8,77
HÄR FÅR ÄLDRE MINST OLÄMPLIGA LÄKEMEDEL
1. Västmanland 6,92
2. Gotland 7,01
3. Kalmar 7,21
4. Gävleborg 7,24
5. Sörmland 7,49
VANLIGASTE OLÄMPLIGA LÄKEMEDLEN
Det tre vanligaste i regionen:
1. Tramadol
2. Propiomazin
3. Hydroxizin
Tema äldrevård Nyheter
Polyfarmaci vanligt hos äldre
Motion och vänner lika viktigt på äldre dagar
rchers in Stockholm h
are for elderly people
Intervjustudie om de allra äldstas levnadsvillkor
Äldre har fått fler häl
men klarar vardagen
"De här siffrorna är inget att vara stolt över"
4 NYHETER
Gasutsläpp i Lysekil
Modulbostäder utreds
En av tio äldre i reg
Lokalt 7
NYHETER 5

Clinical impact

Our major clinical impact over the last two years has been in the area of drug use in older people and can be summarized as follows:

Our major clinical impact over the last two years has been in the area of drug use in elderly people and can be summarized as follows:

- By using the computerized techniques we developed for analyzing drug utilization data from the Swedish Prescribed Drug Register, we regularly assist the National Board of Health and Welfare and the Swedish Association of Local Authorities and Regions (SALAR, SKL) in their annual comparisons of the quality of health care. These measurements have also played a major role in the successful initiative to improve drug use in older people. This initiative has been a part of the agreement between the government and SALAR to support long-term improvement work that focuses on improving the quality and cohesiveness of the care of the most frail elderly persons, and even though this initiative is ended, the monthly measurements continues, as they are appreciated among both the counties and municipalities.

- Since 2000 we have developed a computerized decision support system (miniQ) to facilitate prescribing and drug utilization reviews in eldercare. The system, which is web-based, has three interlinked components: miniQ for physicians and nurses, SeniorminiQ for patients and relatives, and Monitor which provides support for pharmacological experts. miniQ is implemented in several counties in Sweden and since 2016 provides the basis of an *EIT Health* project aiming at adapting the system to other European countries, starting with UK and Spain.

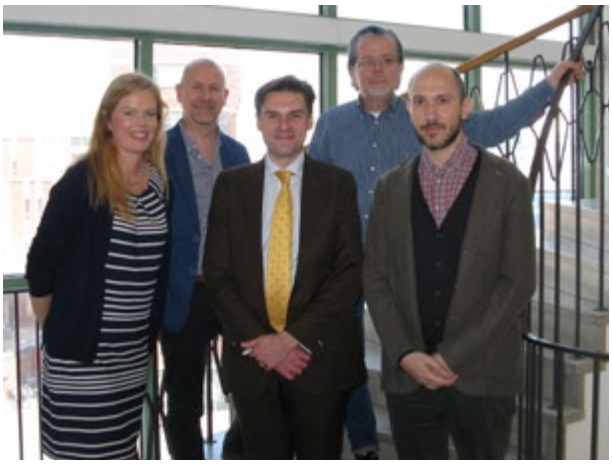


Photo: Maria Yohuang

EIT health project kick-off, 23 May, 2016 at ARC. From the left: Kristina Johnell, ARC, Stephen Chapman, Keele University, UK, Luke Bracegirdle, Keele University, UK, Johan Fastbom, ARC, and Giuseppe Fico, from Universidad Politécnica de Madrid, Spain.

- Quality of drug use in elderly people. Our longstanding research in the area of geriatric pharmacology and pharmacoepidemiology and participation in the development of national indicators for drug therapy in the elderly have likely played a role in the reported continuous improvement in the quality of drug use in elderly people since 2005 (Socialstyrelsen 2017).

Selection of outreach activities and events

Open house at the House of Aging Research
The Aging Research Center, Stockholm Gerontology Research Center, and the Swedish Dementia Centre held a well-visited Open House on Thursday October 27, 2016.

The morning program featured seminars held by researchers from the House of Aging Research. Visitors were able to try their grip strength and their sense of smell at SNAC-K and test Hjärnlabbet's cognitive memory training. There was also a poster exhibition and a book and information stand.

The noon program at Aula Medica offered lectures (in Swedish). Her Majesty the Queen of Sweden opened the program.

Photo: Yanan Li

- ARC researchers contributed five symposia, oral, and poster presentations, and was one of the exhibitors at the 23rd Nordic Congress of Gerontology (23NKG) held in Tampere, Finland, on June 19–22, 2016. The theme of this year's congress was "Good Ageing, Better Health."

- The conference Forte Talks was organized by Forte as a forum for discussion between researchers, policy makers, and care users. It was held March 8-9, 2016, and ARC contributed presentations, a seminar, and posters and was an exhibitor at the conference.

- An information meeting for SNAC-K study participants took place October 14, 2015. Nearly 700 people participated in the day's two lecture sessions.

- ARC co-organized the conference "Horizons for Comparative and Integrative Research on Ageing and Health" together with CASE and AgeCap. The conference assembled 300 participants and was funded by the Swedish Research Council.

- "Defeating Alzheimer's disease and other dementias: a priority for European science and society" is a report co-authored by researchers from ARC and was presented at a workshop hosted by the European Parliament in Brussels on March 15, 2016, during the Brain Awareness Week 2016 also published in the Lancet Neurology.

Photo: ARC colleagues

ARC exhibiting at the 23NKG in Tampere.

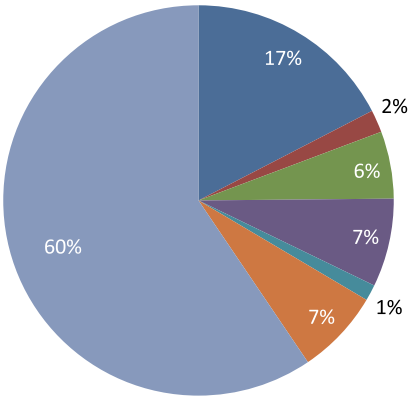
Photo: Pia Gudmundsson

Co-organizers Laura Fratiglioni, ARC, Boo Johansson, AgeCap, and Susanne Iwarsson, CASE.

Finance and funding

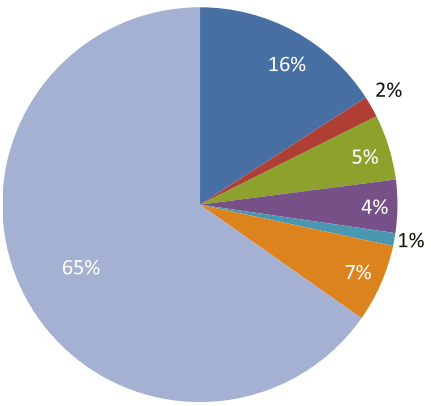
Income

Summary of major financial resources in 2015 and 2016.



ARC income 2015
Total budget: 71 MSEK

- Forte: Center of Excellence
- SU: Matching funds
- KI/NVS department: Activity based matching funds
- KI: Internal competitive funds
- KI: Undergraduate education
- Af Jochnick Foundation: Donation
- National/International agencies: Research Grants



ARC income 2016
Total budget: 78 MSEK

- Forte: Center of Excellence
- SU: Matching funds
- KI/NVS department: Activity based matching funds
- KI: Internal competitive funds
- KI: Undergraduate education
- Af Jochnick Foundation: Donation
- National/International agencies: Research Grants

List of external funders

Major funders (in alphabetical order)

European Union

Jochnick Foundation

Swedish Research Council for Health, Working Life and Welfare (Forte)

The Swedish Research Council (*Vetenskapsrådet*)

Other funders (in alphabetical order)

E & W Cornell Foundation

Dementia Fund (*Demensfonden*)

Gamla tjänarinnor Foundation

Gun and Bertil Stohne Foundation

Hjärnfonden

King Baudouin Foundation

King Gustaf V and Queen Victoria's Foundation

Luxembourg Institute of Socio-Economic Research (LISER)

Max-Planck-Institut

NordForsk

Nordic Research Councils for the Humanities and the Social Sciences

Ragnhild and Einar Lundström Memorial Foundation

Sigurd and Elsa Golje Memorial Foundation

Stiftelsen Svenska Diabetesförbundets Forskningsfond

The Swedish Foundation for International Cooperation in Research and Higher Education, STINT

Stockholm County Council/ALF

The Hierta-Retzius

The National Board of Health and Welfare (*Socialstyrelsen*)

The Solstickan Foundation

The Söderström-Königska Foundation

The Wallenberg Foundations

Triton Advisers (Sweden) AB

Appendix

Publications

Original articles

A. *Longevity, morbidity and functioning*

1. Andel R, Silverstein M, Kåreholt I. The role of midlife occupational complexity and leisure activity in late-life cognition. *J Gerontol B Psychol Sci Soc Sci*. 2015;70(2):314-21.
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C. Health trends and inequality

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E. Miscellaneous

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Review articles

A. Longevity, morbidity and functioning

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B. Treatment and care of elderly persons

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C. Health trends and inequality

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D. Brain aging

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Other publications

197. Winblad B, Qiu C, Ballard C, Johansson G. Evidence-based prevention and treatment of dementia - Authors' reply. *The Lancet Neurology*. 2016;15(10):1007-8.

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Book chapters

D. Brain aging

200. Lövdén MB, L., Lindenberger U. The link of intellectual engagement to cognitive and brain aging. In: Park DC, Cabeza R, Nyberg L, editors. Cognitive neuroscience of aging: Linking cognitive and cerebral aging. *New York: Oxford University Press*. 2015 [in press].

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Reports

205. Fratiglioni L, Santoni G. Demens. In: Backhans M, Stjernberg Forsberg J, Lager A. (ed.) Folkhälsorapport 2015: Folkhälsan i Stockholms län. *Stockholms läns landsting* 2015

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207. Lundberg O, Dahl E, Fritzell J, Palme J, Sjöberg O. (2016). Social protection, income and health inequities. Report. *Copenhagen: WHO Regional Office for Europe*.

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Doctoral dissertations

A. Longevity, morbidity and functioning

209. Shakersain B. Impact of nutritional status and diet on cognitive decline and survival [Thesis]. *Stockholm: Karolinska Institute*t. 2016.

B. Treatment and care of elderly persons

210. Gransjön Craftman Å. Medicine management in municipal home care; delegating, administrating and receiving [Thesis]. *Stockholm: Karolinska Institutet*. 2015.

211. Sköldunger A. Dementia and use of drugs: economic modelling and population based studies [Thesis]. *Stockholm: Karolinska Institutet. 2015*.

C. Health trends and inequality

212. Heap J. Living conditions in old age: Coexisting disadvantages across life domains [PhD Thesis]. *Stockholm: Stockholm University*. 2016.

213. Kelfve S. Gotta survey somebody: methodological challenges in population surveys of older people [PhD Thesis]. *Stockholm: Stockholm University.* 2015.

D. Brain aging

214. Bellander M. Plasticity of memory functioning: genetic predictors and brain changes [PhD Thesis]. *Stockholm: Karolinska Institutet*. 2016.

215. Håkansson K. The role of socio-emotional factors for cognitive health in later life [PhD Thesis]. *Stockholm: Karolinska Institutet*. 2016.

216. Pantzar A. Cognitive performance in old-age depression [PhD Thesis]. *Stockholm: Karolinska Institutet*. 2015.

217. Svärd J. Emotional facial processing in younger and older adults [PhD Thesis]. *Stockholm: Karolinska* Institutet. 2015.

218. Wang R. Cardiovascular risk factors, brain structure, and cognitive decline in old age: A population-based study [PhD Thesis]. *Stockholm: Karolinska Institutet*. 2015.

International forum

2015

Date	Speaker	Title
May 26	**Emiliano Albanese**, Professor, University of Geneva, Geneva	Worldwide perspective on dementia
June 2	**Alan Gow**, Assistant Professor School of Life Sciences, Heriot-Watt University, Edinburgh	Lifestyle factors and the ageing brain
June 4	**Amaia Calderón Larrañaga**, Postdoc Hospital Universitario Miguel Servetx	Multimorbidity: Towards a shift in the focus of etiologic research
June 9	**Gabriele Doblhammer**, Professor Institute for Sociology and Demography, University of Rostock, Germany	Years of life with dementia are compressed at old age. Short-term trends in incidence and death rates of dementia between 2006/07 and 2009/10 Based on German health insurance data
Sep 4	**Brent Small**, Professor University of South Florida, Tampa	Is cancer a risk factor for cognitive decline in late life?
Sep 23	**Monique Breteler**, MD, PhD German Center for Neurodegenerative Diseases (DZNE) within the Helmholtz Association	Population-based research on brain, body and behavior: lessons from the past, directions for the future
Oct 1	**Åsa Hammar**, Professor University of Bergen	Depression and cognitive functioning
Nov 19	**Mark D Hayward**, Professor University of Texas, Austin	Trends and group difference in the association between educational attainment and adult mortality. Implication for understanding education's causal influence

2016

Date	Speaker	Title
Feb 24	**Simon Bell**, Associate Professor, Monash university, Melbourne, Australia	Medication use in aged care facilities: why is it increasing and what should we do about it?
June 2	**Amir Sariaslan**, Postdoc, Department of Psychiatry, University of Oxford	Family-based designs in studies of social/environmental living conditions
Sep 28	**Gindo Tampubolon**, PhD, Research Fellow University of Manchester, UK	The long arm of childhood conditions around the world
Nov 29	**Antonia Trichopoulou**, MD, PhD, Professor University of Athens Medical School, Greece	Social conditions as fundamental causes of health Nutrition and active aging
Dec 1	**Marc J. Poulin**, Professor University of Calgary, Canada	Effects of aerobic exercise on cerebrovascular health and cognitive performance in older adults: insights from the Brain in Motion study
Dec 6	**Stephen Carter**, Research Fellow University of Manchester, UK	Ageing and Alzheimer's: scientific adventures with PET imaging; from [18F]FDG to [18F]Flutemetamol and beyond

Guest researchers

2015

Junfang Xu, exchange student, Shandong University, Jinan, Shadong, China. At ARC: October 2014 to October 2015. Host: Chengxuan Qiu.

Merike Verrijp, master student in Neuroscience. At ARC: February and March. Supervisors: Miia Kivipelto and Francesca Mangialasche.

Ya Gao, exchange student, Hebei General Hospital/Hebei Medical University, Shijiazhuang, Hebei, China. At ARC: February 2015 to February 2016. Host: Chengxuan Qiu.

Marij Zuidersma, Postdoc, University Medical Center Groningen; Department of Psychiatry, Nederländerna. At ARC: 6 February to 6 March. Hosts: Hui-Xin Wang and Laura Fratiglioni.

Jenny Torssander, PhD, Swedish Institute for Social Research (SOFI). At ARC: 15 April to 19 June. Host: Johan Fritzell.

Edwin Tan, Postdoc, Monash University, Melbourne, Australia. At ARC: 1 May to 1 September. Host: Kristina Johnell

Simone Kuehn, Max Planck Institute for Human Development, Berlin. At ARC: 11-12 May. Host: Martin Lövdén.

Ross Andel, Associate Professor, School of Aging Studies, University of South Florida. At ARC: 8-22 June. Host: Ingemar "Pingo" Kåreholt.

Benjamin Shaw,Professor, School of Public Health and Director, Center for Social and Demographic Analysis, University at Albany, State University of New York. At ARC: 27 May to 7 June, and October. Host: Neda Agahi.

Alan Gow, Associate Professor, Heriot Watt University, Edinburgh. At ARC: 1-2 June. Host: Martin Lövdén.

Merril Silverstein, Professor, Aging Studies Institute, Syracuse University. At ARC: 9-18 June. Host: Johan Fritzell.

Finn Diderichsen, Professor, Social Medicine, Copenhagen University. At ARC: 17-18 June. Host: Johan Fritzell.

Lena Dahlberg, Lecturer at Dalarna University. At ARC: during the fall.

Brent Small, Professor and Director of the School of Aging Studies, University of South Florida, Tampa, Florida. At ARC: 2-8 September. Host: Lars Bäckman.

Linda Enroth, PhD student, Tampere Univerity, School of Health Science. At ARC: 7-25 September. Host: Stefan Fors

Giulia Grande, neurologist, MD, Milano. At ARC: for seven months. Host: Laura Fratiglioni.

2016

Edwin Tan, Postdoc, Monash University, Melbourne, Australia. At ARC: February/March 2016 to 2018. Host: Kristina Johnell.

Muhammad Zakir Hossin, internship, Chess, Stockholm University. At ARC: 20 January to 19 February. Supervisor: Stefan Fors.

Roger Keller Celeste, Senior lecturer, Departamento de Odontologia Preventiva e Social Faculdade de Odontologia, Brasilien. At ARC: 2 February to 30 April. Host: Johan Fritzell.

Alessandra Macciotta, Master Student in Biostatistics. At ARC: January to June. Hosts: Debora Rizzuto and Laura Fratiglioni.

Roger Dixon, Professor, University of Alberta, Edmonton, Canada. At ARC: 9-17 July. Host: Lars Bäckman.

Benjamin Shaw, Professor, School of Public Health and Director, Center for Social and Demographic Analysis, University at Albany, State University of New York, University at Albany, USA. At ARC: 18 April to 27 May. Host: Neda Agahi.

Haiping Duan, Postdoc, Qingdao Medical University & Qingdao Center for Disease Control and Prevention, Shandong, China. At ARC: 1 June to 20 Augusti. Host: Chengxuan Qiu.

Lei Feng, Research Assistant Professor, Department of Psychological Medicine, Yong Loo Lin School of Medicine, National University of Singapore, Singapore. At ARC: May to October. Host: Chengxuan Qiu.

Lasse Tarkianen, postdoc, Helsinki University. At ARC: 15 October to 15 December. Host: Johan Fritzell.

Linda Kridahl, PhD Student, Stockholm University. At ARC: October and November. Host: Carin Lennartsson.

Alessandra Maciotta, Master Student, Department of Statistics and Quantitative Methods, University of Milano-Bicocca. At ARC: October to December. Hosts: Debora Rizzuto and Laura Fratiglioni.

Overview of number of employees per sector and per level

Sector Medicine N=26	Sector Psychology N=26	Sector Socialgerontologi N=14
3 Professors 2 Senior lecturers 2 Research associates 8 Post docs 8 PhD students 1 Scientific coordinator	2 Professors 3 Researchers 5 Research associates 3 Post docs 10 PhD students 2 Research assistants 1 Lab manager	2 Professors 1 Senior lecturer 1 Researchers 2 Research associate 2 Post docs 6 PhD students
Technical staff 2 Database managers 1 Lab technician	Administrative staff 3 Administrators 2 Coordinations	

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