

Projekttitel	Dnr
Långtidsstress i den yrkesverksamma befolkningen – ökar det risken för hjärtkärlsjukdomar	160340

Projektledare
Professor <b>Tomas Faresjö</b> , HMV-Linköpings universitet

## Content:

### The scientific objective and background

We set out on this research journey with a firm perception that we could measure long-term stress by cortisol levels in human hair. We had further a notion that long-term stress exposure might affect different cardiovascular risk factors and even increase the risk for myocardial infarction. How stress could lead to cardiovascular diseases is the main topic of this project by the STRESSHEART Research Group. We know that working life today generates stress onset leading to sick leave, burn-out syndrome, and not least cardiac events. We also know that acute stress could lead to myocardial infarction. Most studies in this field point out that long-term stress exposure is a risk factor for a cardiac event, but the empirical evidence for this is unfortunately scarce. This depends to a great extent that we until recently only have been able to measure spot-time stress levels and not long-term stress exposures in humans. However, a new biological marker measuring cortisol in human hair has been developed and applied by our STRESSHEART Research Group and has been utilized in this project. This biomarker gives us the opportunity to record stress levels and HPA-axis activity retrospectively over periods of months. This new biomarker has been found to be stable and reliable in research and has the potential for clinical applications.

The human body could handle stress, but when mobilizing resources to deal with extreme, repeated, or constant threats without sufficient periods of recovery it is thought that the stress system actually could cause harm to the body. Hence, time is an important factor when considering the harmful effect of stress on the individual and the evidence for stress as a cause of a range of diseases in modern industrial societies has grown stronger in recent decades. Stress is probably one of the main factors negatively affecting health, resulting in an increased incidence of different illnesses like; diabetes type II, obesity, and cardiovascular diseases.

This project is a unique opportunity to elucidate the importance of long-term stress on cardiovascular risks for middle-aged working persons in a major population study. We expect to identify how exposure to long-term stress measured biologically by cortisol in hair could affect cardiovascular risks like blood pressure, lipids, inflammation and arteriosclerosis, and cardiovascular diseases like myocardial infarction. We will further elaborate if there are gender differences in these respects and also differences between younger and older middle-aged persons. Both symptoms and signs of cardiovascular diseases are different between men and women. There are also potential gender differences in stress exposure, stress onset, and also ability to cope with stress and its later manifestations of increased clinical risks.

### **Project objectives**

The overall aim of this project is to elaborate the importance of long-term stress exposure, measured by a new biomarker, hair cortisol concentration, on cardiovascular risks and cardiovascular diseases for middle-aged men and women. The aims are further to;

- Investigate the association between long-term stress exposure measured by hair cortisol concentrations and established cardiovascular risks factors; like blood pressure, heart rate, lipids and BMI and to inflammation markers and atherosclerosis.
- Determine the level of hair cortisol concentrations as well as testosterone concentrations in patients recently hospitalized for myocardial infarction, in comparisons with healthy individuals from the general population in The SCAPIS-study.
- Study if different working conditions for men and women in public or private sector is associated to long-term stress levels measured in hair cortisol concentrations.
- Consider if the application of this biomarker could help identify persons at risk for myocardial infarction or other cardiovascular diseases and allow to timely preventing a serious cardiac event.

### **Implementation of the project**

#### **The SCAPIS study**

The data in this project derives from The Swedish CARDIO Pulmonary bioImage Study (SCAPIS) that is a national prospective observational study of a randomly selected sample of totally 30.000 middle-aged persons (50-65 years) from the general population. The subjects in SCAPIS are recruited and all examinations performed at six Swedish university hospitals (Göteborg, Linköping, Malmö/Lund, Stockholm, Uppsala and Umeå) where each site has recruited around 5.000 representative individuals. SCAPIS is one of the largest medical research projects ever started in Sweden.

#### **The STRESSHEART Study**

Research Group are responsible for an additional data collection within the SCAPIS-study at the Linköping site, focusing on measuring cortisol concentration in hair (hair is also collected at the Umeå site). This data collection within SCAPIS will form the database for this project. In late June 2018 the data collection and inclusion of participants was ended at the Linköping site, in all just over 5.000 participants. Within the SCAPIS an extensive questionnaire covering data of lifestyle, working life and different psychosocial factors is collected besides extensive clinical laboratory data as well as clinical investigations of heart and lung functions. Since our research group is contributing with the stress analysis, we have also access to other relevant part of the SCAPIS data collection, including data from questionnaires and clinical laboratory data of cardiovascular risk factors.

#### **Methodological development**

Quite early in this workperiod we initiated contacts with our colleagues at Umeå University led by my associate professor Per Dahlgvist. Since Umeå university also is a part of the SCAPIS-study and that they after contact with us in Linköping also collect hair samples from their participants in Umeå. We have decided that we in Linköping also should analyse their samples and that we later in some analysis could pool our two samples. Thus using the same laboratory for the analysis of both samples. Further advantages is that we then get a larger sample to analyse and that these come from two parts and populations in Sweden.

Following the discussion and results of the international publications in the field of cortisol measurement in human hair, have initiated some methodological development of our methodology. Our used methodology when analysing cortisol in hair, The RIA-method, which we found very robust, could of course be compared with other methods like photo-spectrometer methods. We decided in cooperation with Umeå university to perform testproject where we compared these two methods, keeping up a methodological development.

Another question that emerge from the international publications in this field is how long back in time we could analyses cortisol in hair. The standard answer has been three months back and possibly up to six months back in time. The perception is that after that time period the cortisol levels will deteriorate, washed-out or maybe disappear. We have therefore, as a methodological development initiated a test where we analyse long hair especially collected for this purpose. These hair samples are at least 24 cm long possibly permitting us to analyse cortisol levels month by months up to two years back in time.

## Achieved results

The first two-years in our project was devoted to the biological analysis of cortisol concentrations in hair at our laboratory, applied for a SCAPIS sample of almost 5.000 participants. This was an investment that thereafter has lead to several important publications. Most of our papers are published, but we have also some additional papers that are submitted to international journals and some in the pipeline under development.

### **Our findings from the manuscripts in brief summary**

Our research group has shown that the biomarker “cortisol in hair” seems to be a valid and reliable measure that could be applied in research of cardiovascular diseases (**article 1**). We have shown a that the stress hormone cortisol precedes a serious cardiac event i.e myocardial infarction. The cortisol levels rise a month before the event, both for males and females.

Further analysis focused on possible pathways to test the direct and indirect association between HCC and Cardiovascular diseases (CAD) and if this relationship was mediated by Standard modifiable risk factors like diabetes, hypertension and hyperlipidemia (**article 2**). We found in path models, that 80% of the association between ln(HCC) and CAD were mediated by SMuRFs. The SMuRFs diabetes, hyperlipidemia, and hypertension mediate the association between ln(HCC) and CAD. But some association around 20% between ln(HCC) and CAD did not operate via the SMuRFs considered. This opens up for other pathways possibly through atherosclerosis or inflammation.

We have further elaborated a new method where we could measure the male hormone testosterone in the same hair sample. These analysis indicates that the hormone cortisol and testosterone are interrelated. We have found that after increasing cortisol levels follows a period of lowering testosterone levels (**article 3**). This reflects a natural biological mechanism that previously only has been shown in animal studies on monkeys and for singing birds. Decreasing testosterone levels may be among the pathophysiological processes preceding myocardial infarction. This gives us new knowledge of how the human stress-respons is functioning and might also have some clinical implications.

Prodromal cardiac symptoms are warning signals preceding cardiac disease. In this study (**article 4**) we analysed possible gender differences in prodromal symptoms as well as

established risk factors for MI. Most common symptom was chest pain at the onset of MI. We also found some working life related factors of importance. Influences of the social environment, such as experiences of serious life events, strained economy, depression, stress, and sleep deprivation were stronger as potential risk factors for myocardial infarction in women than among men. These results give a deeper understanding of diagnostic differences between men and women and could inspire to a more gender-oriented cardiovascular preventive work.

As a part of the methodological development we published a paper (**article 5**) where we demonstrate that it is possible to measure hair cortisol concentrations month-by-month for a retrospective period of up to 24 months (2-years back in time). This finding is in contrast to standard scientific perceptions that it is only possible to measure HCC up to 6 months retrospectively. In upcoming studies of for example workrelated factors these findings could be useful since we could go backwards in time up to two years and measure stress exposures.

The risk to be affected by a serious cardiac event before the age of 50 years is relatively small, especially for females. But if it happens there must some plausible explanations. Young persons under the age of 50 years affected by myocardial infarction was therefore compared to middle-aged myocardial infarction patients in the ages 51-65 years old (**article 6**). This study revealed, that persons under the age of 50 affected by acute myocardial infarction showed more of the traditional cardiovascular risk factors like high blood pressure, and higher BMI, and were more exposed to some psychosocial risk factors. The risk profile of these young persons affected by AMI was in some respects more exaugurated than for the middle-aged group. This young group of AMI-patients should get special attention by preventative strategies.

Cortisol is one of the major stress hormones, with profound effects on most organs. Long-term exposure of elevated cortisol levels has detrimental effects, including increased risk for cardiovascular diseases and death. Our large SCAPIS-dataset based on around 5.000 participants from the general population is probably one of the largest cohorts of its kind where hair cortisol concentrations is measured. We have made a basic overview of how hair cortisol concentrations might be associated with a large set of cardiovascular risk markers and cardiovascular diseases for a middle-aged cohort from the general population (**article 7**). Most of the conventional cardiovascular risk factors like; hypertension, high cholesterol were significantly associated to HCC. HCC was significantly associated to CACs score for females. Of cardiovascular diseases earlier myocardial infarction, atrial fibrillation, heart failure, bypass surgery, diabetes type 2, and asthma were all significantly associated to HCC, but not stroke or angina pectoris. Several potential biomarkers were also significantly associated to HCC like Fasting glucose, cholesterol, leukocytes, and high sensitive CRP with values outside the reference limits. These analyses of cortisol levels exhibit that the biological stress hormone cortisol measured in hair is a potential general risk factor for cardiovascular risks and diseases.

For factors in working life, we we did not found any major differences in HCC when analysing factors from the traditional demand-control model (**article 8**). The main findings in this report of working life was that those men reported that they on daily basis had to work fast had significantly ( $p=0.03$ ) higher HCC. Also males that reported that they almost never get help and support from their immediate boss had significantly ( $p=0.02$ ) higher HCC. The working life has changed and factors that were important previously like lack of influence and control of daily work might not any longer be so important, maybe the working conditions has changed to the better in these aspects. But support at work from colleagues and not least from the nearest boss still seems to be important factors to reduce a stressful working situation.

**Below follows an overview of the publications and manuscript from our research group:**

**1. Elevated levels of cortisol in hair precede acute myocardial infarction. Published in Scientific Reports (2020).**

Long term stress exposure is typical for modern societies and might trigger different diseases. This case-control study reveals that persons who had suffered an acute myocardial infarction (AMI) had elevated cortisol concentrations in the month before the acute event. Middle-aged patients admitted to cardiology clinics with acute myocardial infarction (AMI) ( $n = 174$ ) were compared to 3156 controls from a population-based cohort in southeast Sweden. The median Hair Cortisol Concentrations (HCC) for those who had suffered an AMI was 53.2 pg/mg compared to 22.2 pg/mg for the control group ( $p < 0.001$ ). In bivariate analysis, higher levels of HCC were strongly ( $OR = 5.69$ ) and statistically significantly associated with current AMI status. The discrimination of cases with AMI from controls remained statistically significant ( $OR = 5.04$ ) even after controlling for established cardiovascular risk factors in a multivariate analysis.

Middle-aged persons with acute myocardial infarction had significantly elevated cortisol levels during the month before the cardiac event. This was evident for both men and women. The biomarker cortisol concentration was independently and statistically significantly related to AMI. Chronic stress seems to be a new promising risk factor for AMI.

**2. Standard modifiable cardiovascular risk factors mediate the association between elevated hair cortisol concentrations and coronary artery disease. Published in Frontiers in Cardiovascular Medicine (2022).**

Increased cortisol exposure is a risk factor for coronary artery disease (CAD). It is not clear to what degree this risk is independent from the standard modifiable risk factors (SMuRFs) dyslipidemia, hypertension, and diabetes. The aim of this study was to use path analysis to test the direct and indirect association, mediated by SMuRFs, between long-term cortisol levels measured in hair cortisol concentration (HCC) and CAD. Hair was sampled from patients admitted with acute myocardial infarction ( $n = 203$ ) and a population-based sample without a diagnosis or symptoms of CAD ( $n = 3,134$ ). The HCC was analyzed using radioimmunoassay and all the participants reported whether they were diagnosed with or treated for diabetes, hypertension, and hyperlipidemia. Path analysis was used to test to what degree the association between logarithmized ( $\ln$ ) HCC and CAD was direct or indirect, mediated by SMuRFs. Participants with CAD had elevated HCC compared to those without elevated HCC [median interquartile range (IQR): 75.2 (167.1) vs. 23.6 (35.0) pg/mg,  $p < 0.0001$ ]. Higher HCC was associated with diabetes, hypertension, and hyperlipidemia, which, in turn, were associated with CAD. In path models, 80% of the association between  $\ln(\text{HCC})$  and CAD were mediated by SMuRFs, while the direct path between  $\ln(\text{HCC})$  and CAD was not statistically significant. The SMuRFs diabetes, hyperlipidemia, and hypertension mediate the association between  $\ln(\text{HCC})$  and CAD.

Some association between  $\ln(\text{HCC})$  and CAD did not operate via the SMuRFs considered and might have a pathway through atherosclerosis or inflammation.

**3. Decreased Testosterone Levels Precede a Myocardial Infarction in Both Men and Women. Published in American Journal of Cardiology (2022).**

The potential role of the hormone testosterone in the risk for myocardial infarction is investigated in this study of middle-aged men and women compared with a large random control sample from the general population. Radioimmunoassay was used to measure testosterone levels in hair, approximately 1 month and 3 months before an ST-

elevation or non-ST-elevation acute myocardial infarction. Mean testosterone levels were measured for middle-aged men and women (n = 168) with diagnosed myocardial infarction (the acute myocardial infarction [AMI] cases). As controls, n = 3,150 randomly selected subjects from the general population of similar age were measured at 1 time point. No significant difference in testosterone levels in hair was found 3 months before AMI for men and women compared with the controls. However, 1 month before AMI, the testosterone levels were decreasing (p < 0.001) for both men (from 2.84 to 2.10 pg/mg) and women (from 1.43 to 1.10 pg/mg), indicating that a decrease in testosterone concentrations precedes a severe cardiac event. Conventional cardiovascular risk factors were tested as confounders but did not alter this tendency. The AMI cases were also compared with a randomly selected second control group from the general population (n = 205), for whom comparable segmental hair analyses were conducted. A tendency of some decreasing testosterone levels, also in the small control group, was only significant for men. This control group was a small sample, and there might be some natural biologic variation in testosterone levels over time. This study indicates that decreased testosterone levels may be among the pathophysiological processes preceding myocardial infarction and merits further investigation.

#### **4. Cardiovascular Risks Before Myocardial Infarction - Differences Between Men and Women. Published in BMC Cardiovascular Disorders (2022).**

Prodromal cardiac symptoms are warning signals preceding cardiac disease. Previous studies have shown some gender differences in prodromal symptoms as well as established risk factors for MI. This study aims to map possible gender differences in social factors and established risk factors preceding myocardial infarction (MI). The study includes data of N=213 middle-aged men and women, all diagnosed with myocardial infarction (ICD-10 I21.9) from the region of south-east Sweden. They answered a questionnaire at discharge from the cardiologic clinic and additional clinical data from medical records were merged from the National Swedeheart Register. The dominant prodromal symptom for both sexes were experience of chest pain at the onset of MI. The major gender differences were that significantly more females (p=0.015) had a hyperlipidemia diagnose. Females also reported to have experienced higher stress load the year preceding myocardial infarction with serious life events (p=0.019), strained economy (p=0.003), and reports of sadness/depression (p<0.001). Females reported higher perceived stress load than men (p=0.006). Men had higher systolic blood pressure than women at hospital admission and a higher systolic- and diastolic blood pressure at discharge. Influences of the social environment, such as serious life events, strained economy, depression, stress, and sleep deprivation were stronger as potential risk factors for myocardial infarction in women than among men. Of the traditional risk factors only, hyperlipidemia was more frequent among women. These findings could contribute to a deeper understanding of diagnostic differences between gender, as well as a more gender-oriented cardiovascular preventive work.

#### **5. Like year rings on a tree – measuring cortisol concentration in hair month-by-month two years retrospectively. Accepted in All Life Journal (2022).**

Previous studies of cortisol concentrations in hair have concluded that it is possible to measure up to 6 months retrospectively. This study shows contradictory that it is possible to analyse hair cortisol concentrations month-by-month for a retrospective period of up to 24 months. The study population was 48 women in the age range 20-51 years, all with hair of length of 24 cm or longer. The participants completed a questionnaire that examined exposure to life stressors and potential confounders. Competitive radioimmunoassay was used to extract and analyse cortisol levels in hair. The overall intraclass correlation for the participants was substantial (ICC = 0.38, 95% CI

0.29, 0.49), indicating a strong within-person correlation during the growth period. The median levels of cortisol were reasonably stable. Less frequent hair washing was associated with less-negative slopes, but the wash-out effects in general were relatively small.

We conclude that it is possible to detect hair cortisol concentrations on a monthly basis at least two years back in time. Changes in hair cortisol concentration are more likely to be related to life stressors than changes due to time since growth.

#### **6. Cardiovascular and psychosocial risks among young patients with Acute Myocardial Infarction. Submitted to BMC Cardiovascular Disorders (2022).**

Despite improvements in the treatment and prevention of cardiovascular disease since the 1960s, the incidence of cardiovascular diseases among young people has remained the same for many years. This study aimed to compare the clinical and psychosocial attributes of young persons affected by myocardial infarction under the age of 50 years compared to middle-aged myocardial infarction patients 51-65 years old. Data from patients with a documented STEMI or NSTEMI elevated acute myocardial infarction in the age groups up to 65 years, were collected from cardiology clinics at three hospitals in southeast Sweden. The Stressheart study comprised a total of 213 acute myocardial infarction patients, of which  $n=33$  (15.5%) were under 50 years of age and  $n=180$  (84.5%) were middle-aged, (51-65 years). These acute myocardial infarction patients filled in a questionnaire at discharge from the hospital and further information through documentation of data in their medical records.

Blood pressure was significantly higher in young compared to middle-aged patients. For diastolic blood pressure ( $p=0.003$ ), systolic blood pressure ( $p=0.028$ ), and mean arterial pressure ( $p=0.005$ ). Young AMI patients had a higher ( $p=0.030$ ) body mass index (BMI) than the middle-aged. Young AMI patients were reported to be more stressed ( $p=0.042$ ), had more frequently experienced a serious life event the previous year ( $p=0.029$ ), and felt less energetic ( $p=0.044$ ) than middle-aged AMI patients.

This study revealed, persons under the age of 50 affected by acute myocardial infarction showed more of the traditional cardiovascular risk factors like high blood pressure, and higher BMI, and were more exposed to some psychosocial risk factors. The risk profile of these young persons affected by AMI was in some respects more exaugerated than for the middle-aged group. This younger group of patients should not be disregarded by preventative strategies.

#### **7. Hair cortisol levels in relation to cardiovascular risk factors and chronic conditions in a large middle-aged population. Submitted to Frontiers in Cardiovascular Medicine (2023).**

The question if long-term stress could be associated to cardiovascular risk factors and cardiovascular diseases has been debated for long. There is a general perception that indicators of stress is related to cardiovascular risks, but there has been a lack of appropriate methods of analysing long-term stress, until now when measurements of hair cortisol is available. The aim of this publication is to give an overview of HCC in realtion to a broad variety of established cardiovascular risk factors and cardiovascular diseases in large sample from the general population. Cortisol is one of the major stress hormones, with profound effects on most organs. Long-term exposure of elevated cortisol levels has detrimental effects, including increased risk for cardiovascular diseases and death. Our large SCAPIS-dataset based on around 5.000 participants from the general population s probably one of the largest cohorts of its kind where hair cortisol concentrations is measured. We have made a basic overview of how hair cortisol concentrations is associated to a major set of cardiovascular risk markers and cardiovascular diseases for a middle-aged cohort from the general population. Most of

the conventional cardiovascular risk factors like; hypertension, high cholesterol were significantly related to HCC. HCC was significantly related to CACs score for females. Of cardiovascular diseases earlier myocardial infarction, atrial fibrillation, heart failure, bypass surgery, diabetes type 2, and asthma were all significantly related to HCC, but not stroke or angina pectoris. Several potential biomarkers were also significantly related to HCC like Fasting glucose, cholesterol, leukocytes, and high sensitive CRP with values outside the reference limits. These analyses of cortisol levels exhibit that the biological stress hormone cortisol measured in hair is a potential more general risk factor for cardiovascular risks and diseases.

## **8. Biological stress and working life factors. Manuscript to Occupational Medicine (2023).**

Psychosocial factors in working life has for decades been focused on the demand – control model and social support at work and also the effort-reward imbalance model. But occupational life changes and new factors might now be of more importance. In this study we examined long-term stress exposure in relation to the traditional demand control model but also for major occupational groups in a gender perspective. Earlier studies of occupational stress has mainly been based on self-reported stress and not biological stress. In this study a sample of totally N=3921 middle aged person (n=3209 females and n=1712 males) from the general population participated, they all were included from the Linköping and Umeå SCAPIS-study.

There were few statistically significant differences in biological stress (HCC) when analysing factors deriving from the demand-control model. Males that reported that they on daily basis had to work fast had significantly ( $p=0.03$ ) higher HCC, but this was not noticed for females. No difference in biological stress (HCC) was found when it comes to influence over amount of work or what you do at work. Neither for influence on decisions that affect your work or influence over what you do in your work. But, males that reported that they almost never get help and support from their immediate boss had significant ( $p=0.02$ ) higher HCC, OR=1.57 (1.06-2.31). Occupational groups with raised HCC among males were found for; health care workers, administrative and service jobs, self-employed, medical doctors, police, firemen and military. For females raised HCC was found for; service jobs, academics, after school staff/pupil assistants. Hair cortisol measurement within occupational health research is still in its early stage. Longitudinal studies where targeting specific occupations or occupational groups are needed to clarify how hair cortisol can be used to identify risk factors in working life that could negatively affect health.

## **Implemented efforts to put the results to practical use**

Members in our research group has participated in different interviews in newspapers and magazines where longstanding stress has been in focus. Our PI has also participated in a filmed lecture by the Swedish Educational Television (UR) that has been nationally broadcasted in Swedish television. See link:

<https://urplay.se/program/215545-ur-samtiden-popularvetenskapliga-veckan-2019-kan-man-mata-stress-i-manniskors-har>

Besides media publications our STRESSHEART-project was invited to give an oral presentation at The Swedish Heart and Lungfundation conference “Dag för genombrott” arranged in Linköping October 12, 2017.

See link: <https://www.hjart-lungfonden.se/-Nyheter-/Dag-for-genombrott-i-Linkoping/>

Another even larger event by the Swedish Heart and Lungfundation will be at Linköping Konsert & Kongress October 3, 2018 were our STRESSHEART research Group invited and gave a presentation of our project (audience 2.500 persons). The Swedish Heart and



Lungfederation had recently a special day for researchers in Stockholm October 2022 were several members in our research group participated in the discussion and planning of the SCAPIS II study.

It would have been desirable if our research group could have had some contacts with trade unions and their partners to present and discuss our research and our findings concerning long-term stress and working life. But, to reach out and get these kind of contacts is not so easy for a research group at the university.

To keep up our international contacts some of us have for years now participated in scientific work shops arranged by the EPOCH study group and the INRICH Society. Regularly webshops and also works shop on different locations during the years. Has taken place. We have met and had discussions of our STRESSHEART-project with colleagues from Stanford University, University of Montreal, University of Sydney, University of York, University of Edinburgh and Erasmus university.

## Publications, presentations and dissemination within the framework of the project

### Publications from the project:

1. Faresjö T, Strömberg S, Jones M, Stomby A, Karlsson JE, Östgren CJ, Faresjö Å, Theodorsson E. Elevated levels of cortisol in hair precede acute myocardial infarction. **Science Reports**. 2020 Dec 31;10(1):22456.
2. Stomby A, Strömberg S, Theodorsson E, Olsen Faresjö Å, Jones M, Faresjö T. Standard Modifiable Cardiovascular Risk Factors Mediate the Association Between Elevated Hair Cortisol Concentrations and Coronary Artery Disease. **Frontiers in Cardiovascular Medicine**. 2022 Jan 25;8:765000.
3. Faresjö Å, Preinbergs J, Jones M, Lebena A, Theodorsson E, Faresjö T. Decreased Testosterone Levels Precede a Myocardial Infarction in Both Men and Women. **American Journal of Cardiology**. 2023 Jan 1;186:223-227.
4. Nyström A, Strömberg S, Jansson K, Faresjö ÅO, Faresjö T. Cardiovascular risks before myocardial infarction differences between men and women. **BMC Cardiovascular Disorders**. 2022 Mar 17;22(1):110.
5. Faresjö Å, Le Tran A, Olsen O, Faresjö T, Theodorsson E, Jones M. Like year rings on a tree – measuring cortisol concentration in hair month-by-month two years retrospectively. **All Life Journal**. 2022, (accepted manuscript).
6. Faresjö Å, Karlsson J-E, Segerberg H, Lebena A, Faresjö T. Cardiovascular and psychosocial risks among young patients with Acute Myocardial Infarction. **BMC Cardiovascular Disorders**. 2022 (submitted manuscript).
7. Faresjö Å, Lilja M, Theodorsson E, Stomby A, Quist H, Östgren C J, Dahlqvist P, Söderberg S, Blomberg A, Faresjö T. Hair cortisol levels in relation to cardiovascular risk factors and chronic conditions in a large middle-aged population. **Frontiers in Cardiovascular Medicine**. 2023 (manuscript).
8. Faresjö Å, Lilja M, Theodorsson E, Stomby A, Quist H, Östgren C J, Dahlqvist P,

Söderberg S, Blomberg A, Faresjö T Biological stress and working life.  
**Occupational Medicine.** 2023 (manuscript).

#### **External contacts and Media contacts in the Stressheart project**

When our project was launched and AFA decided to financially support the STRESSHEART-study there were several articles and interviews in national media both newspapers and radio. A sample of all these media publications of our research with links below:

Sveriges Radio

<https://sverigesradio.se/artikel/5726329>

Tidskriften Kollega:

<https://kollega.se/stress/stressen-kan-ta-livet-av-dig>

Arbetsliv

<https://www.prevent.se/arbetsliv/forskning/2018/haret-avslojar-stressnivan/>

Arbetarskydd

<https://www.arbetarskydd.se/nyhetsarkiv/ny-metod-kan-upptacka-langvarig-stress-6902271>

Utbildningsradion/TV (lecturer by professor T. Faresjö)

<https://urplay.se/program/215545-ur-samtiden-popularvetenskapliga-veckan-2019-kan-man-mata-stress-i-manniskors-har>

Göteborgsposten:

<https://www.gp.se/nyheter/sverige/harstran-ska-avsloja-stressen-pa-iva-1.60675882>

Tidskriften Måbra

<https://www.mabra.com/halsa/studie-haret-kan-forutsaga-risken-for-hjartinfarkt/7290988>

Tidskriften Näringskällan

<https://www.naringskallan.se/haranalys-varnar-for-hjartinfarkt/>

Dagens medicin

<https://www.dagensmedicin.se/arbetsliv/arbetsmiljo/harstran-ska-avsloja-stressen-pa-iva/>

Svenska Dagbladet

<https://www.svd.se/a/0EAaQ6/forskning-haret-kan-visa-din-stress-langt-tillbaka>

Forskning.se

<https://www.forskning.se/2021/02/10/stresshormon-i-harstran-varnar-for-hjartinfarkt/#>