Progress reports summary – BMI – fall 2020-21

Water Lab

Patricia Akao, Graduating BMI Fellow

Treated wastewater can be an alternative source for depleting water sources for crop irrigation, however conventional wastewater treatment plants are energy intensive and costly to construct and operate, especially for low-middle income countries. The present study focused on improving the quality of wastewater by incorporating coupled microalgae-bacteria biofilm (CMBB) treatment to the wastewater ponds. Standard polyether sponges were dipped in the raw wastewater samples to enhance biofilm development on the sponges. The enriched sponges were used to treat wastewater, with or without external energy for aeration. Wastewater parameters were analyzed during the enrichment and treatment processes. The CMBB technology improved effluent quality at similar levels to aeration, however saving the energy costs, reducing 36% of chemical oxygen demand (CODt) within 24 hours and 71% within 4 days. The values of biochemical oxygen demand (BOD), ammonium and phosphates reduced by 80%, 64% and 95% within 7 days, respectively. The values for COD and BOD obtained were below the maximum allowed for reuse and discharge."

Following the improvement that was obtained using coupled microalgae-bacteria biofilm (CMBB) to improve wastewater parameters, the capability of the CMBB to remove recalcitrant pharmaceuticals from wastewater was tested. Four pharmaceuticals were chosen (sulfamethoxazole, venlafaxine, carbamazepine and iohexol) and tested by the ability of the consortia to remove these compounds. Also, it was decided to characterize the biofilm, identifying what types of bacteria and microalgae are present at the biofilm and to understand their role at the removal. Three concentrations of CMBB were chosen (20, 40 and 80 milliliters of wastewater per sponge) and light and dark conditions were tested (L and D). No removal of iohexol was seen after 5 days, on dark and light conditions. For venlafaxine, during the first day it was possible to see 82% removal at L-CMBB-20, 62% removal for L-CMBB-40 and 36% removal for L-CMBBB-80, after5 days the removal reached 90% for L-CMBB 40 and 20. In the dark, 24% of venlafaxine were removed and kept steady until day 5. Carbamazepine removal reached 43 to 50% between 1-5 days for L-CMBB-20, and oscillated between 2 -36% between LCMBB-40 and 80 during these 5 days. The results obtained for sulfamethoxazole were inconclusive.

Patricia is currently at the final stages of writing her Ph.D. dissertation and we are very proud of being a part of her progress.
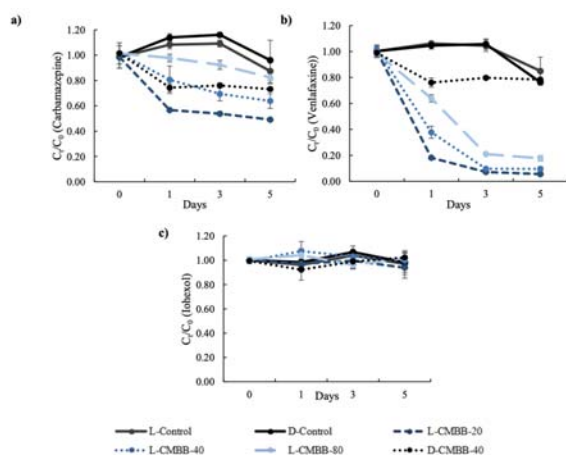
Fig. 3. Removal of carbamazepine (a), venlafaxine (b) and iohexol (c) from wastewater. Errors bars represent the standard deviation of three independent experiments.

Ariel Aviram, BMI Fellow

Worldwide water crisis is a severe issue that humanity is facing throughout this century. This water governance caused by the combined effects of population growth and demographic changes, aside with climate change, water source contamination, depletion, and the ways we mismanage water. Access to safe water and proper sanitary conditions are essential variables that give the population the physical and mental capacity to develop outside the vicious and endless cycle of life in poverty. Technological interventions such as access to water for a remote village are expected to improve living conditions for the community members, but also to abolish old traditions and customs and create a dramatic change in the familiar and safe social and political local environment. Very rarely, do the two disciplines of culture and technology merge their methods in a mutual research project to achieve a real well-adopted, and sustainable change.

The focus of this research is to figure out the appropriate ways to circumvent geopolitical, cultural, and social barriers, in order to find the right ways of Implementing water treatment. For the first year, the field study will be conducted in Tanzania in collaboration with Innovation Africa (IA). During the field study, the way how water drilling projects affect African societies will be examined, as well as whether the interventions that were done by IA encountered some barriers. This field study has a unique contribution to this research as it gives the opportunity to investigate the communities along a process of technology implementation. The study will also explore whether social, cultural, or geopolitical barriers affect the project implementation and success.

Michale Goldenberg, BMI Fellow

The research is focused on developing a simple, inexpensive electrochemical sensor for the detection of nitrates in water through the use of voltammetry. The sensor will measure the ionic content of the water, and interface with the internet to send information about contamination to consumers. By monitoring their water, consumers can prevent consumption of polluted water, as well as determine their need for a more complex purification system. Various

voltammetry methods were compared, including cyclic voltammetry and square wave voltammetry. Both techniques provide a simple, linear relationship between concentration and current. By looking at the differences in the current peaks at different concentrations, it is clear that square wave voltammetry far outperforms cyclic voltammetry in its ability to sense changes in nitrate concentration.
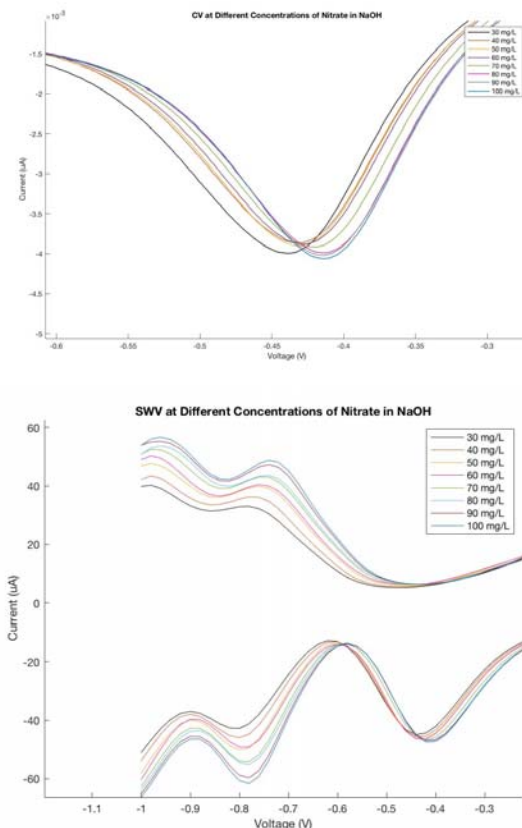
Selda Edris, BMI Fellow

The subject and field of the research remained the same: wastewater. The researcher has joined an existing study on developing sustainable carriers to streamline sewage treatment processes in India. In the study, the aim is to try to arrive at a structure and material suitable for use in this field. Selda's role in research is to lead the field of experiments in this study. The research team had recently made connections with sewage treatment facilities to carry out the field experiments. Selda is in charge of the preparatory work for the experiment, such as calibration and ordering equipment. Currently, two trials are being planned within the MTAs to test the feasibility of the various carriers.

3D printed carriers aimed for testing

Asaf Pras, BMI Fellow

At least 2 billion people worldwide use drinking water sources that are contaminated with feces, causing waterborne diseases; poor sanitation, poor hygiene, and unsafe drinking water result in a daily death rate of more than 800 children under 5 years of age from diarrheal diseases. This study shows the feasibility of a novel method to cast the presence of fecal coliforms (FC) in drinking water sources by applying a multilayer perceptron artificial neuron network (MLP-ANN) model. The model gives a binary answer for FC presence or absence in raw water, using a few water quality and geographical parameters, which can be monitored in real time as predictors with low-cost equipment. Using 62,000 samples to train, validate and test the model, a total accuracy of 84.56% was obtained using temperature, pH, electrical conductivity, turbidity, dissolved oxygen, and biological oxygen demand (BOD) as water-quality inputs and the water source and location (states in India) as geographical inputs; sensitivity reached 93.63%, meaning that most of the FC-contaminated samples were classified correctly. Using the model without BOD changed the accuracy and sensitivity slightly, to 84.43% and 93.70%, respectively. Thus, low-cost monitoring of inputs in real time is possible. Results show that the MLP-ANN model can be used as a tool for bacterial monitoring and management in water, reducing the need for time-consuming or expensive tests.

Fig. 1. Evaluation metrics as a function of thresholds
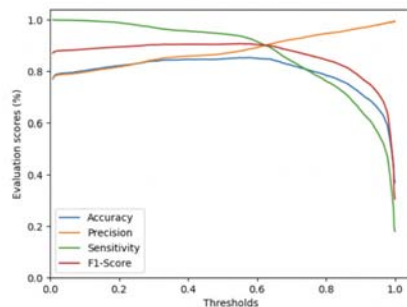
Renewable energy Lab

Tamir Yeshurun, BMI Fellow

This research focuses on extracting the photon external luminescence efficiency for characterizing materials and devices for solar energy conversion. A photoluminescence quantum yield measuring system was constructed and performed the incident wavelength dependent photoluminescence quantum yield of an InP wafer was measured. Over the next year, an optical model will be built, simulated, and compared the spatial photon external luminescence efficiency extracted from measurements for different materials and various solar devices. This year there will also be a collaboration with Prof. Ziv Hameiri's group at the University of New South Wales, Australia, with the purpose of expanding possible experiments using various characterization techniques.
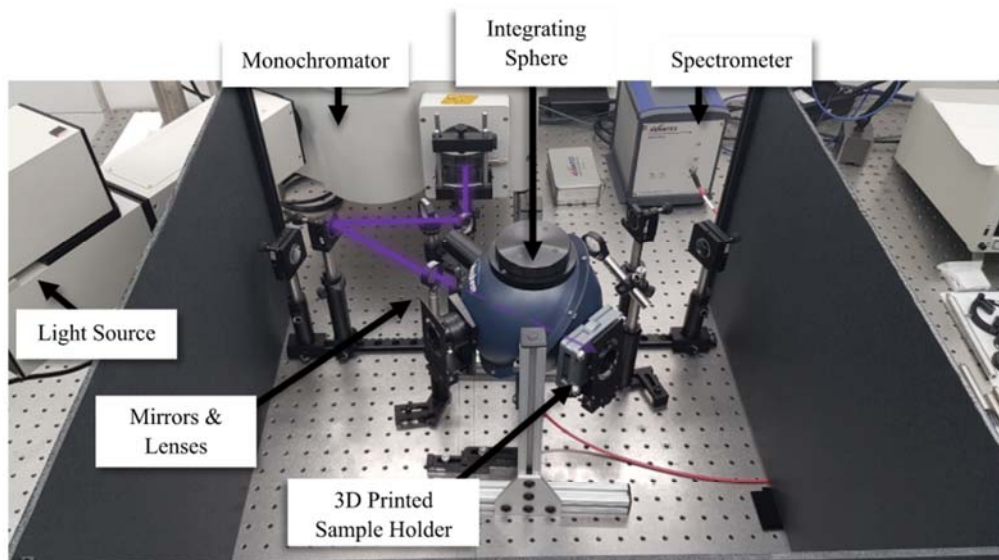

Figure 1 – PLQY Experiment layout. The image depicts the light (purple line) from the monochromator output to the sample inside the integrating sphere. The light is focused on the sample via a set of lenses and mirrors. The PL signal is collected with an optical fiber at the bottom of the integrating sphere to a spectrometer.

Alon Herman, BMI Fellow

Estimates show that about two thirds of the world's population experience severe water scarcity at least one month every year. Water desalination is already in widespread use in many parts of the world, however current industrialized technologies require extensive capital and energetic costs, making them impractical in the developing world where access to clean drinking water is most needed. Pollution of ground and wastewater is also a major source of scarcity, for example heavy metal ions pollution (such as zinc, nickel, lead, etc.) due to advanced industrialization, or Arsenic pollution in developing countries. Therefore, In the face of ever-growing demand, the need for small-scale, low cost and reliable water treatment technologies is of great importance. The project focuses on developing a Ratchet-based Ionic Pump in order to tackle this challenge.
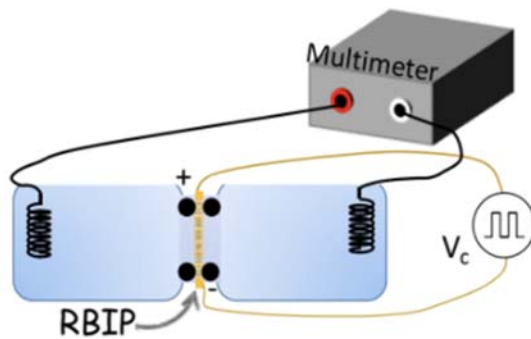
Eyal Sasson, BMI Fellow

From its beginning, electricity markets were dominated by a single electricity utility, which controlled all components of electricity supply – generation, transmission, distribution, and retail supply. The high infrastructural costs require a vast initial investment and create a unique costs structure yielding a natural monopoly–a single company that supplies the entire demand. The growing market of renewable energy provides a window of opportunities for the privatization of electricity generation. Transforming electricity markets into efficient and competitive markets would increase production efficiency, reduce electricity prices and improve service quality alongside reducing negative externalities and climate mitigation. While there is a plethora of empirical literature that tries to estimate the effect of market structure on electricity prices, less attention has been given to investigate what role institutions have in the privatization of the electricity market and how institutional quality stimulates renewable energy penetration more successfully.

This research extends the understanding of the pre-conditions underlying the creation of new markets and contributes to a better understanding of the role of institutional quality in the context of emerging markets. To empirically investigate the theory, the research exploits panel data of annual state-level variables covering 47 countries from 1996 through 2019, to explore the effects of institutional quality (e.g., efficient regulatory, well-defined and secured property rights, and sophisticated financial systems) on renewable energy growth. Panel data sets are better able to study cross-sections dynamic changes over time. So far - the research points to that total electricity production is growing more rapidly than electricity production from renewables. Once we normalize by the population size, electricity production per capita is roughly constant over the past ten years, while there is a significant trend upwards in electricity production from renewables per capita. These trends make ground for optimism, indicating that while total electricity production is growing at the same rates as population growth, electricity production from renewables is growing much faster than population.

Total electricity production
Total electricity production from renewables
Electricity production per capite
Electricity Production from renewables per capita
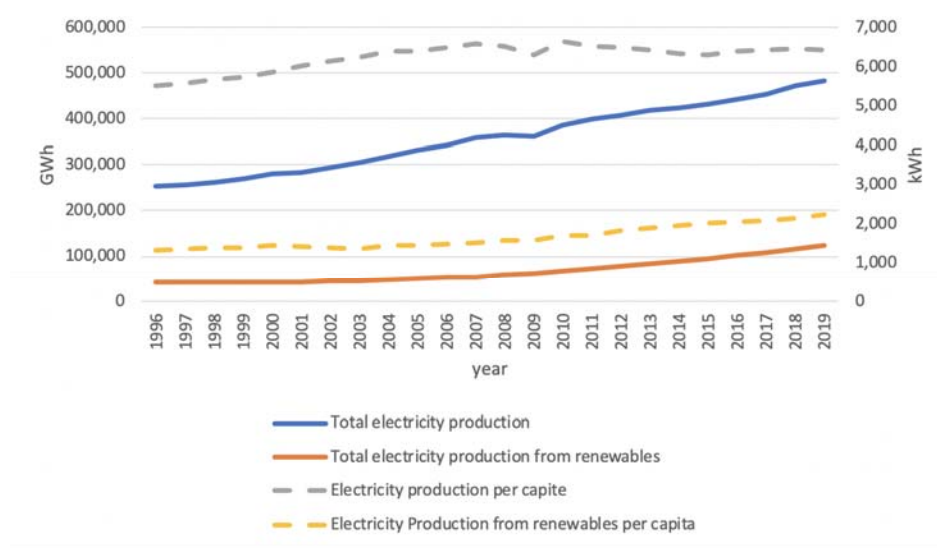
## Conflict Resolution Lab

Nadine Knab, BMI Postdoctoral Fellow
This research provides evidence for specific connections between emotions and prosocial action tendencies to support refugees. The issue is investigated in two studies by including a general population sample and a unique sample of people working in charity and human-rights organizations. Based on previous research, this research predicted different prosocial actions and differentiated between *hierarchy-maintaining* and *hierarchy-challenging actions* (prosocial actions that may maintain vs. challenge unequal power relations between advantaged and disadvantaged group members)*,* we provide important theoretical and empirical knowledge to tailor and develop interventions addressing current needs of refugees. For this reason, this research provides implications beyond academic research, for instance, for organizations interested in fostering support for refugees or migrant groups more generally.

Nora Meissner, BMI Fellow
The overall research project examines how cities deal with the social and economic incorporation of forced migrants. So far, the research has focused on the challenges and the opportunities that local governments face as they mediate between national migration control policies and the influx of asylum seekers in precarious socio-legal situations. In face of the COVID-19 pandemic we have expanded and diversified the ongoing research project and are now working on two interrelated studies simultaneously. The first study focuses on the case of Haifa, to contribute to the understanding of local refugee integration and migration governance in localities that are not central gateways to migration and yet important for grasping new dynamics of refugees' dispersal. The second deals with the severe consequences of the pandemic for marginalized communities and civil society action. It is of vital importance to provide up-to-date knowledge to understand contemporary crises and their impact on dynamics and outcomes of local and global migration governance.

Asylum seekers' dispersion throughout Israel

Total number (not including those born in Israel):
31,012 (Ministry of Interior, Oct 2020)
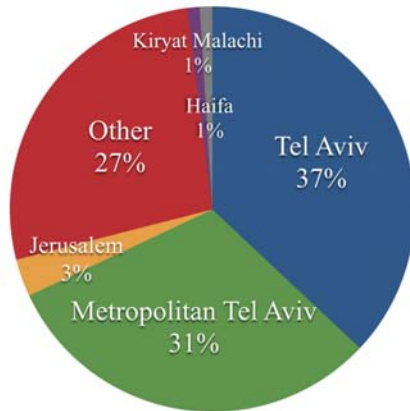
The percentages shown here are an estimate based on numbers by the Ministry of Interior from 2018 and 2020.

Kiryat Malachi 1%
Haifa 1%
Other 27%
Tel Aviv 37%
Jerusalem 3%
Metropolitan Tel Aviv 31%

Gal Factor, BMI Fellow

Gal is currently involved in two research projects: The first project is investigating Meta-Perceptions in the Israeli context. Meta perceptions is a term describing how a group "thinks" a second group is perceiving them. Exaggerated meta-perceptions means that although the outgroup perceives the ingroup in a certain objective score, the ingroup believes they (the outgroup) have an overly pessimistic perception of themselves. For example, both Democrats and Republicans believed that the other group holds high prejudice scores towards them, although actual prejudice scores between the groups were lower than they each anticipated. Currently, the work relies on replicating the meta-perception study in Israel, looking at two specific pairs of social groups: Jewish Seculars and Ultra-Orthodox (Haredim), and Israeli Jews and Arabs. The hypothesis is that similar exaggeration in meta-perceptions will be replicated in the Israeli context between these pairs of groups. In addition, there will be an examination of whether different variables like group power and media exposure influence these meta-perceptions.

A second line of research is examining the Tendency for Interpersonal Victimhood (TIV). This psychological construct implies that people have a general tendency to look at themselves as victims. When this tendency is high, people can have more aggressive behaviors on the interpersonal level. Currently, the research group is working on two different studies that should help better understand the behaviors of high-TIV individuals. In one study, the researchers seek to examine how individuals will react to an external signal of victimhood, by another person. The prediction is that higher-TIV individuals will be less willing to help others who signal themselves as victims. In this study, elements of virtue within the victims' signal also will be implemented, to observe if these have any effect on the high-TIV participants' willingness to help the victims. A second study will examine how higher-TIV individuals react to apologies following an episode of interpersonal transgression. It is believed that participants with high TIV will have a harder time forgiving people who hurt them and will be more revengeful in comparison to lower-TIV participants.

Inequality Lab

Eve Guterman, BMI Fellow

The current research focus is on gathering data to support the following hypothesis: A Distributed Ledger Technologies (DLTs) intervention that *breaks monopolies on **capital formation*** will mitigate the ***redistribution problem***, resulting in *increased individual purchasing power and increased social welfare.* Such data, which is acquired with the help of GoodDollar, the first of its kind Universal Basic Income initiative based on DLTs. The acquired data leads to a conclusion that Latin America and Argentina in particular is an early adopter of the initiative. The data, which is in progress of being extracted - falls into two categories. The first being a systematic categorization of the services offered and requested in the groups, namely, reviewing and sorting the types of transactions and goods/services that have evolved organically around the existence of GoodDollar as a new store of value and means of exchange, including their associated "market value" on the informal GoodDollar marketplace. The second is that the relevance of the aforementioned hypothesis should be assessed through a qualitative survey, which is currently in the works.
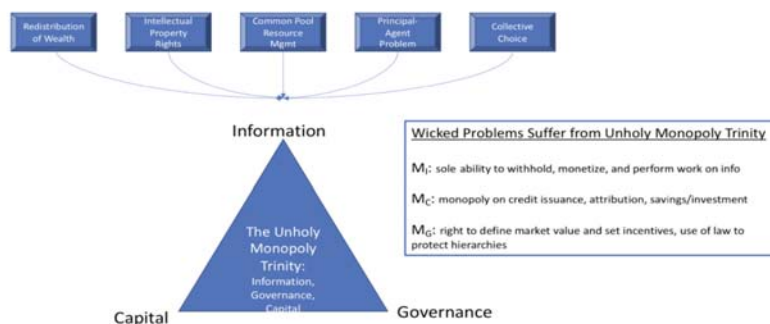

Stav Cohen, BMI Fellow

Universal Basic Income (UBI) is a policy, which focuses on reducing economic inequality that has been on the rise globally. From a theoretical standpoint, UBI would decrease the Gini coefficient, allowing for a more egalitarian society. The purpose of this study is to analyze opportunities for UBI distribution in Israel, while considering various sources for budgeting the policy, some in a form previously overlooked by scholars. This project will examine existing funding methods by analyzing the governmental budget articles that can be repurposed to fund UBI. Such articles will include those that have been prone to overfunding without significant improvements in services they provide and those that will no longer be useful if UBI is adopted.
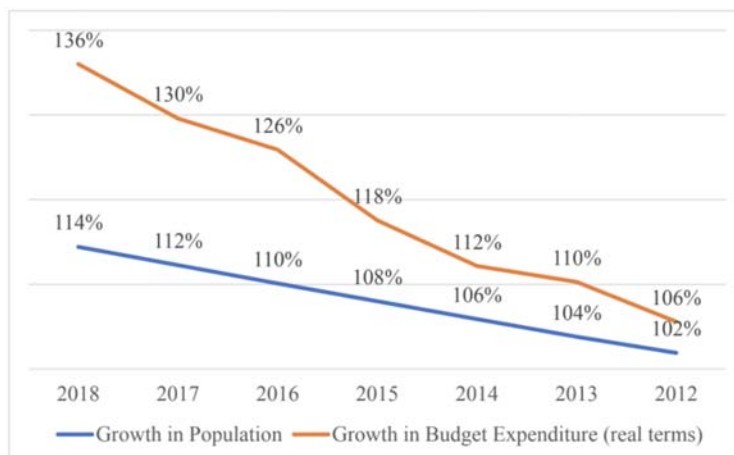
Elad Guttman, BMI Fellow

Elad is a part of Dr. Oren Daneli's research group, who is currently working on three research projects: **The first** one deals with a concept known as outside options index (OOI), which essentially is the options available to workers in a labor market. Analyzing German data, the findings make a significant contribution linking the difference in OOI and the gender wage gap (see attached figure). **The second** research revisits the US wage inequality model through using skill-replacing routine-biased-technological-change (SR-RBTC), with technology replacing the usage of skill in routine tasks. **The third** project introduces a data driven way to design the optimal policy experiment for increasing chances of escaping poverty. Analysis is conducted through the data that was collected in three US cities from poverty-stricken individuals. The findings suggest that income-increasing interventions for the poor need to be broader than simply human capital or place-based policies.
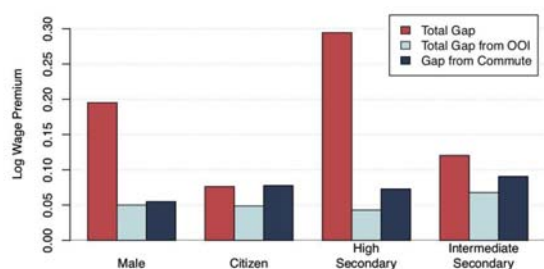
This figure shows the extent to which the between-group wage gap can be explained by differences in the OOI. It shows the overall gap, the gap that can be attributed to the OOI and the gap that is specifically driven by commuting differences.

Demography Lab

Shayna Bernstein, Postdoctoral BMI Fellow
Lifespan inequality is the most important issue, as all other inequalities operate on a notion of 'life'. This research project aims to answer the following question: How does excess exposure to mortality shape individuals' perceived longevity, that is, their own survival expectations and subjective life expectancy? When addressing this question, the focus relies on lifespan inequality in the U.S., specifically the racial gap and educational gradient. By comparing expected survival between groups, individual experience of lifespan inequality can be fully understood. The findings show that disadvantaged groups tended to be optimistic about their mortality prospects, and in one case, with race, that the inequalities in perceived life expectancy switched direction. It can be assumed that disadvantaged groups are not experiencing or internalizing the lifespan inequalities, they have historically been subject to, it would be incorrect. Further research is required to understand how predictions of survival and life expectancy differ by race.
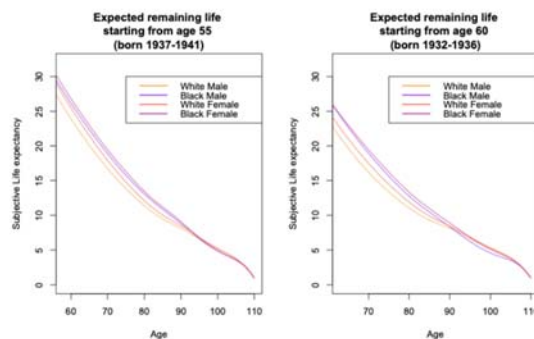

Figure 2. Subjective life expectancy for white and black men and women from age 55 (those born between 1937 and 1941) and from age 60 (those born between 1932-1936).

Atalia Regev, BMI Fellow
This research project aims to examine the different trajectories in which childhood socioeconomic status (cSES) shapes older adults' expected lifespan. Possible statistical models and databases through which the research question could be studied have been examined. The intention is to analyze data from the Health and Retirement Study (HRS), a representative longitudinal panel study of United States adults aged 50 and over. The different pathways in which cSES may shape perceptions of the risk of mortality over the life course will be assessed using nested discrete-time hazard models (Hayward & Gorman, 2004), regressing subjective life expectancy (Perozek 2008) on Vable and colleagues' cSES index. (Vable et al., 2017).