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Qatar Foundation (QF), headquartered in Doha and celebrating its 25th anniversary this year, is a nonprofit organization made up of more than 50 different entities devoted to improving education, research, and community development.

Precision medicine is an important strategic focus area for Qatar’s health care sector and for QF. The foundation has invested significantly in precision medicine to improve the health of the citizens and residents of Qatar as part of a mandate from Her Highness Sheikha Moza bint Nasser, chairperson of QF. To date, QF has funded over 160 precision medicine–related research projects that have been completed, and more than 100 that are currently in progress (see “Tracking families over time”).

“There is a tremendous amount of research on precision medicine that’s happening in Qatar,” says Richard O’Kennedy, Vice President for Research, Development, and Innovation at QF. “We are very interested in developing the best health care possible for our citizens, residents, and the broader world. Precision medicine is crucial in that regard, because it allows for the tailoring of both diagnostics and treatments to the individual. This is the way forward in all aspects of health care and the education associated with it,” he adds.

At QF, precision medicine goes way beyond genomics. “We do multimodal precision medicine. In addition to other ‘omics data, we’re also looking at clinical, social, behavioral, and lifestyle factors—the entire spectrum of information you can get from individuals. We are maximizing the information involved in our precision medicine program,” says Faisal Farooq, head of the Center for Digital Health and Precision Medicine within the Qatar Computing Research Institute (QCRI), which is part of QF’s Hamad Bin Khalifa University (HBKU) (see “QF’s data-crunching power”).

**From health to disease**

The largest precision medicine effort of QF to date is the Qatar Genome Programme (QGP), which is sequencing the genomes of a large fraction of the country’s healthy population—20,000 have already been sequenced—providing one of the world’s strongest datasets on the Arab genome (see “Shedding light on the Qatar Genome Programme”). “If you look at data across genetic pools around the world, the Arab genome is massively underrepresented. QF is putting Arab genomes on the map,” says O’Kennedy. Importantly, this whole-genome information is being coupled with other ‘omics data as well as deep phenotyping data from Qatar Biobank, another QF research entity, to provide a comprehensive view of patients.

“Until recently, the focus has been on healthy individuals. The program will now shift to look at disease cohorts for conditions such as diabetes, cardiovascular disease, and cancer,” explains David Brown, chief architect at QF’s London-based partner, Genomics England. The program will “bring the clinical research closer to the patients to improve health care in Qatar. That translation of research into clinical care, and then the feedback—as more patients are treated, there will be a bigger repository of information to base decision support on—are the major focus areas,” says Brown.
“These are some of the most impactful diseases that put the greatest strain on the health system in Qatar. We will initially focus on those to get the biggest return on QF’s investment in genomics,” he adds.

QF is also taking part in the fight against the COVID-19 pandemic through participation in a worldwide consortium. The plan is to obtain data from 2,000 people. “We are looking at whether there is a particular genetic makeup that predisposes people to developing a worse form of the disease. It’s very valuable data that, down the line, will also be able to help tailor what kind of treatment a patient receives,” explains O’Kennedy.

**Uniquely positioned for precision medicine**

In many ways, Qatar is an ideal environment for implementing precision medicine. There is good health care available to everyone, says O’Kennedy. Unlike larger countries that have several different health care providers, in Qatar, there’s a much smaller number of players and they are all linked, making precision medicine studies easier to run than in more complicated systems such as in the United States.

Other countries tend to have people from a range of backgrounds; however, due to consanguinity, Qatari nationals are more closely related, which provides a highly similar population in terms of genetic variation. “A homogeneous population is very useful when trying to decipher mutations that are associated with diseases,” explains O’Kennedy.

Qatar’s population is also very digitally aware, and large numbers are using wearable digital health devices. This presents a huge opportunity to collect health-related data (while maintaining data privacy) that can be integrated with the biological information that has been collected, says Farooq.

Qatar’s investment in health care is among the largest in the region. The country has one of the highest per capita health expenditures in the Middle East and is ranked third in the region in health as measured by the UK-based Legatum Institute in their 2019 Legatum Prosperity Index (1).

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**Tracking families over time**

One of QF’s many precision medicine projects is the Qatar Birth Cohort Study (QBIC). Started in 2017, QBIC is one of the only mother-child cohort studies in the Middle East, and the first to allow researchers to address a broad range of hypotheses. “The main aim of the study is to assess the synergistic role of environmental exposure and gene variation on maternal and childhood health,” says Eleni Fthenou, a scientist at QF’s Qatar Biobank and QBIC’s lead principal investigator. In particular, Fthenou and her colleagues are interested in chronic diseases such as diabetes, cardiovascular disease, hypertension, and mental illness, which are more prevalent among Qataris than in the rest of the world.

The goal is to recruit 3,000 pregnant women along with their families. During the initial time point at 12-15 weeks of pregnancy, the women complete a 3-hour visit to the Qatar Biobank, during which they undergo a comprehensive clinical assessment, including having blood and other biological samples collected and completing several questionnaires about various aspects of their lifestyle. The women are followed up again in their third trimester and at delivery. The children are assessed at 1 month, 6 months, 1 year, 2 years, and 4 years. Fathers are invited to participate as well, explains Fthenou.

Currently, Fthenou and her colleagues have enrolled just over 200 women, representing more than 30 nationalities—54% are Qataris, 28% are long-term Arab residents, and 18% are long-term residents of other countries. The mean age of study participants is 29.

The study is being performed in collaboration with Qatar’s Ministry of Public Health, Texas A&M University at Qatar, Qatar’s primary health care centers, and Hamad Medical Corporation. In addition, all protocols and tools used in the QBIC study have been harmonized with European cohorts, enabling better comparisons of data and future collaborations.

“The lifestyle, the climate, the social exposures, type of food eaten—there are lots of environmental differences between the Arab world and the Western world,” says Fthenou.

“This study will bring the Arab genome to the forefront of precision medicine and allow us to better understand and treat the kinds of health problems our population faces.”
Qatar is very unique. Few countries in the Arab world have invested as much in knowledge and capacity building as Qatar. QF has attracted top universities to open campuses here,” says O’Kennedy. Education City, QF’s flagship endeavor, is a 12-km² area that houses satellite campuses of numerous international universities, including Carnegie Mellon University, Georgetown University, Weill Cornell Medical College, Northwestern University, Texas A&M University, Virginia Commonwealth University, and HEC Paris in Qatar. It is also home to QF’s own HBKU, founded in 2010.

“Having these institutions here has solidified a very high level of academic excellence. Campuses that are traditionally thousands of miles apart are now within walking distance in Education City, so there’s a lot of cross-pollination,” says Khalid Fakhro, acting chief of research at QF’s Sidra Medicine hospital and director of Sidra Medicine’s Precision Medicine Program.

QF is working hard to develop researchers and clinicians with the expertise needed for precision medicine. For example, QF offers postgraduate and clinical programs in data informatics, bioinformatics, and genetic counseling. Genomics is a big part of the medical school curriculum. QF also offers continuous education for clinicians on the latest developments in genomics-based diagnostics and treatments. HBKU has a Ph.D. program in genomics and precision medicine that was started 5 years ago. “We’re building capacity from the ground up,” says Fakhro.

Another example of educational capacity building is also happening in Education City, where HBKU faculty are examining ethical questions raised by the field of genomics and precision medicine and how they are viewed by the Islamic religion. “As we enter the era of genomic medicine and attempt to engage the public in precision medicine, we need to frame the discourse in terms of regional beliefs and cultures to ensure there is public acceptance of it,” says Fakhro. “Our collaboration with QF’s Faculty of Islamic Studies is going to facilitate that.”

Worldwide collaborations
QF has partnered with a number of leading international research institutions. In addition to the universities that are part of Education City, Harvard University in the United States and Genomics England are particularly close partners, with a constant flow of individuals and ideas between the organizations.
There are many advantages to collaborating with QF. We have the largest cohort of Arab genomes in the world and great expertise in the area of precision medicine,” says O’Kennedy. The annual Precision Medicine and Functional Genomics Conference, run by Sidra Medicine, brings in experts from all over the world. “In addition, partners get access to the research community in Qatar as well as state-of-the-art health care, including outstanding physicians, and the focus on regional genomics provides our collaborators with understanding of this subject matter,” adds Brown. “We’re very engaged internationally, and we’re hoping to continue to expand our worldwide collaborations,” says O’Kennedy. “Our future is exciting, and we are ready to share our expertise with the world.”

Shedding light on the Qatar Genome Programme

The Qatar Genome Programme (QGP) is the most ambitious precision medicine project in the region. Funded by Qatar Foundation (QF) and launched in 2015, QGP has currently sequenced over 20,000 whole genomes. Importantly, many of these samples also include associated ‘omics data—proteomics, transcriptomics, metabolomics, epigenomics, and microbiomics—explains Said Ismail, director of QGP. Plus, participants in QGP undergo deep phenotyping at the Qatar Biobank—also a QF research entity—including bloodwork, multiple imaging scans, electrocardiograms, bone density scans, and many other tests. The result is an incredible amount of data, making the program the only one of its kind in the Middle East. “Soon, if not already, the Qatari population will be among the most well characterized in the world,” says Ismail.

QGP’s bioinformatics partner is QF’s Sidra Medicine, a world-class medical facility focused on pediatric and women’s health that also serves as Qatar’s national genomics laboratory. QGP has collected genomes not only from Qatari citizens, but also from Arabs living in Qatar long-term, representing the Gulf, Yemen, Iraq, Syria, Jordan, Egypt, Sudan, and North Africa. “We are shedding light on genomes that represent an estimated 400 million people,” says Ismail. “This dataset is badly needed.”

“We’ve had hundreds of researchers mining the data,” says Ismail. “Now, we are ready to shift gears and go from concentrating on research to investigating clinical implementation.” One example of this shift is the Q-chip, a gene array that contains over 400,000 different gene variants. “From QGP, we know what the Qatari-specific variants are, so we put those on a chip in order to improve the diagnostic yield among our population,” Ismail explains. The first version of the chip was created in 2018; a second version is currently being validated.

“Our project isn’t just about sequencing genomes,” says Ismail. “More broadly, we’re laying the groundwork for precision medicine.” This means working on policy, education, genomics research, infrastructure, and eventually incorporating genomic data into electronic medical records. “We like to think we are spearheading the national agenda to make Qatar a pioneer in precision medicine,” says Ismail.

References

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