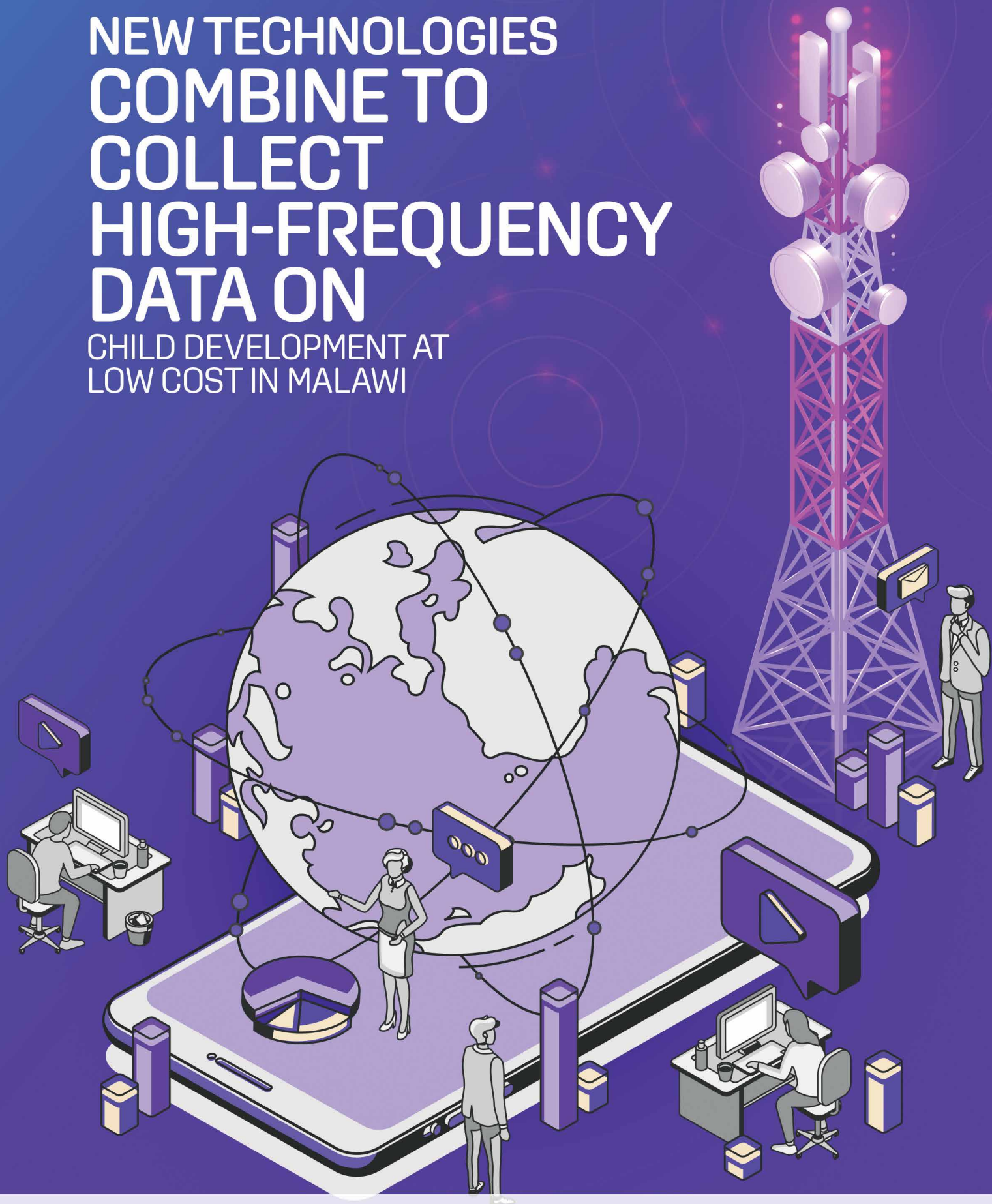
NEW TECHNOLOGIES COMBINE TO COLLECT HIGH-FREQUENCY DATA ON

CHILD DEVELOPMENT AT LOW COST IN MALAWI



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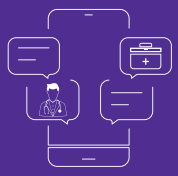
Summary

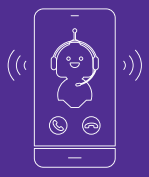
In most developing countries, child development data is collected through expensive, large-scale surveys conducted after lengthy intervals, limiting its value for designing responsive and cost-effective interventions.

In its pilot phase, the Child Development Study tested the use and acceptability of a combination of new technologies to collect these data at high frequency in Malawi. These technologies were supported by traditional methods, such as face-to-face data collection.

Wearable technologies enabled ECG (heart rate) and EEG (brain waves) data to be collected from children once a week. Generally, caregivers and children were accepting this data collection technique.

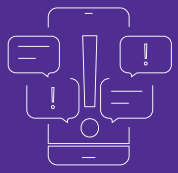


Using proximity sensors, researchers monitored close contact between caregivers and children and assessed responses to text messages encouraging play and health-seeking behaviours.



Robocalls to caregivers' mobile phones successfully elicited day-to-day information on children's health.

The pilot showed that combining these technologies is a successful means of collecting quality data at low cost and high frequency.



Ultimately, such multi-modal approaches can power life-saving disease surveillance and early warning systems, such as for COVID-19.

As the Child Development Study progresses, it will expand and enrich the data collected, adapt and improve the technologies used, and ensure they continue to be accepted by communities. This will be achieved by building links with district authorities and training volunteers from local communities.

Inadequate data is one of the main constraints to highly responsive, cost-effective and evidence-based interventions for child development.

Millions of children in developing countries are unable to achieve their full developmental potential. There is a wide body of evidence on interventions that, when applied correctly, can remedy children's disadvantages. Yet, when resources are limited, policymakers must choose how to allocate resources to the interventions that best address vulnerabilities and help children escape intergenerational cycles of deprivation.

High-quality data on child development is essential to choose and implement cost-effective interventions that have the greatest benefits for child development with limited resources. When data is collected and updated frequently, the benefits are multiplied. It becomes possible to choose the best approach, monitor it, and make course corrections as new information comes in. It also becomes possible to act quickly when conditions change, such as a disease outbreak, and to finetune interventions even for individuals.

In Malawi as in most developing countries, high-quality data on the situation of children and adolescents is not available at high frequency. Existing data sources, such as the Demographic and Health Survey and Multiple Indicator Cluster Surveys provide valuable information, but are largescale snapshots taken at multi-year intervals. With these as the only reliable evidence base to identify pressing needs and evaluate development programmes, children and adolescents are at risk of not receiving the right services at the right time.

In 2018, researchers researchers at the **College of Medicine**, University of Zurich's Center for Child Well-Being and Development (CCWD), with the United Nations Children's Fund (UNICEF) country office in Malawi, began piloting the Child Development Study. This is a platform that combines new technologies to generate critical high-quality data on child development at high frequency.

The pilot phase tested new data collection techniques to provide higher frequency, more accurate and less expensive data than traditional data collection methods. The pilot ended in early 2020, yielding valuable data on feasibility and best practices for high-frequency data collection in resource-poor environments.

These findings will inform the design and rollout of the Child Development Study platform across Malawi.

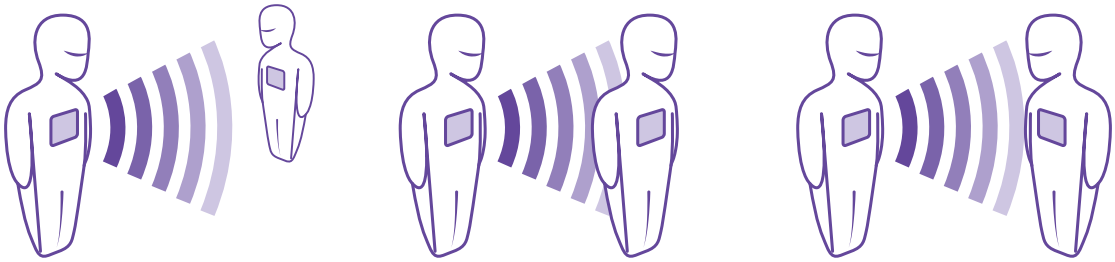
Preliminary findings

Wearable devices can provide reliable, systematic data on critical biomarkers.

Over the course of five weeks, researchers gathered weekly data from children on two critical biomarkers. Under the supervision of their caregivers, community volunteers and community health workers (in Malawi, also known as health surveillance assistants, or HSAs), children participated in weekly 15 minute sessions in which they wore headbands and wristbands which measured their brain waves (EEG) and heart rate (ECG).

Caregivers and children also wore proximity sensors (stored in small cloth bags pinned to their regular clothes) all the time during the day over the course of those five weeks. These allowed the researchers to track the extent and duration of interactions between children and their caregivers, and to map social networks in the village.

Sensors record when and how long caregivers and children are in close contact.



While other studies had collected non-invasive biomarkers from children in developing countries, this was the first ever study to do so weekly and in combination with other data collection modes to provide critical information on healthy development.

This was achieved despite multiple constraints. The first related to power and connectivity: only 18 per cent of Malawian households have access to electricity, and internet coverage is sparse and irregular. The pilot overcame those constraints by using devices with long battery life, that collect data episodically (during sessions, for headbands and wristbands, and upon close contact, for proximity sensors), and that upload data only sporadically (through tablets powered by the research team).

The second constraint, related to the unfamiliarity of the volunteers with wearable technology, was overcome through careful recruiting and training of trusted community members and HSAs.

The third related to data protection and informed consent of vulnerable populations. While UNICEF is still developing global guidelines for data protection with wearable technologies, the researchers worked with health law specialists in Switzerland to develop protocols compliant with Swiss law, which are most likely stricter than existing regulation in Malawi.

Mobile phones are a tool for collecting precise data at high frequency through interactive surveys.

Besides children's biomarkers, caregivers received weekly robocalls to their mobile phones, requesting information about their children in five areas: medical symptoms; nutrition; water and sanitation; early stimulation; and child development. These information helped build up a precise picture of children's health and wellbeing over the study period.

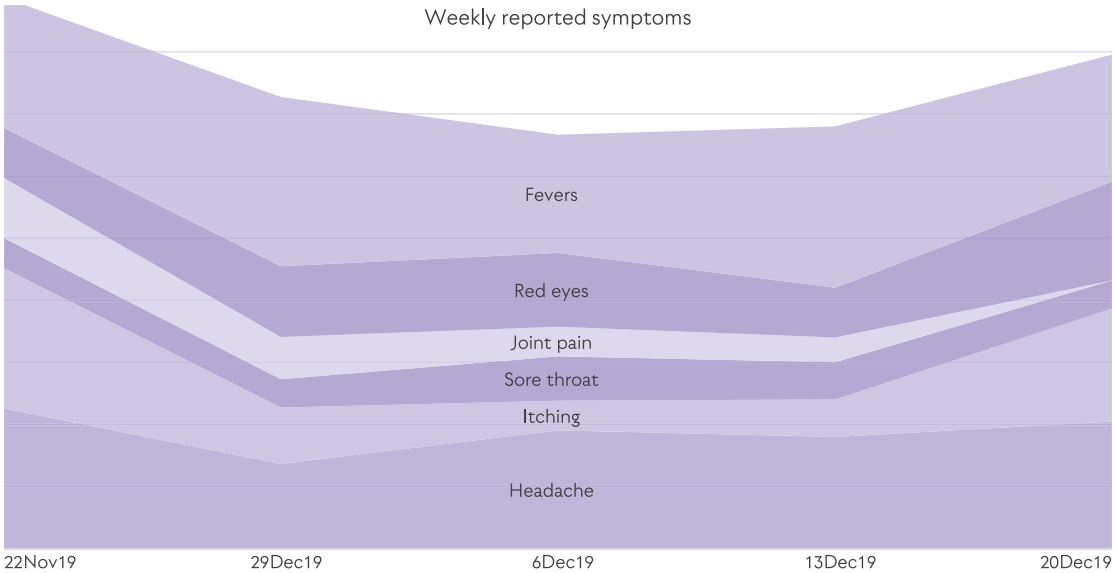
For instance, the weekly survey helped show that in one village, Mdoliro, parents repeatedly answered "yes" to a question asking if they struggled to provide food to their child.

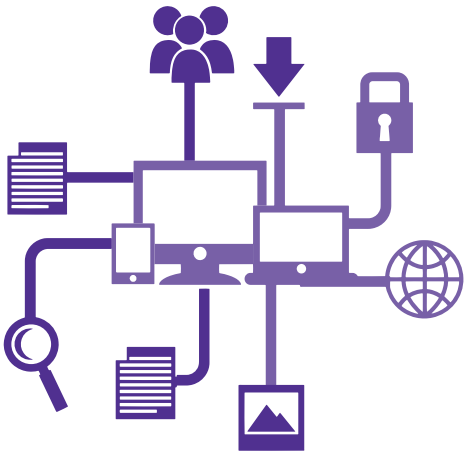
While successful, the test also showed that careful survey design, appropriate incentives, and accounting for phone sharing between family members are important elements for an effective scale up of this mode of data collection.

Face-to-face surveys enrich and validate the data collected by other means.

Household surveys are already a widely used means of collecting data, despite their high cost and low frequency. Through weekly face-to-face surveys using tablets, and by conducting in-person health tests, HSAs and community volunteers complemented and validated the data collected through other modes.

Mobile surveys capture children's symptoms across villages at high frequency





Preliminary evidence shows that caregivers comply with "nudges" sent via mobile phones.

In addition to data collection, mobile phones were also tested as a means of encouraging behaviour change, with the help of proximity sensors.

Nudges – reminders and encouraging messages – were sent to some caregivers using text messages (SMS), urging them to engage in activities such as washing hands or taking children to play with others. The sensor data were then analysed to assess if nudges were followed by increased social contact. The preliminary findings suggest that caregivers respond to nudges by spending more time with their children relative to others who were not targeted by messages.

Moreover, certain types of nudges were followed by spikes in social contacts even amongst families who did not receive nudges, possibly pointing towards broader impacts in the community.

With careful study design and attention to legal and ethical concerns, Malawians accept the use of technology for data collection to improve child development.

The combination of new technologies for data collection raises legal and ethical concerns around data ownership and acceptability. Although all the tools tested were new to the rural Malawians who participated in the study, they were broadly accepted by participants.

At the end of the study, 237 people were interviewed about their experience with the data collection technologies. All 237 said they had received complete and accurate information regarding the study, and over ¾ recalled that data would be fully anonymized.

All participants said that their main reason for participating in the study was to learn about their child's health and development. Parents did not report increased waiting times at health clinics because of the study. Children who were interviewed reported receiving more care and attention since the start of the study.

About 25 per cent reported that other community members who had not participated in the study regarded their participation neutrally, and 28 per cent regarded it positively. These dynamics will be taken into consideration as the study is scaled up.

When it comes to wearables, caregivers and children alike largely reported positive experiences with the technology: only 2 per cent of caregivers reported feeling uncomfortable with the technology when used at their homes, and none reported discomfort with data collection at the clinic.

This suggests that working with trusted community members – HSAs and community volunteers – facilitated acceptance.

Way forward

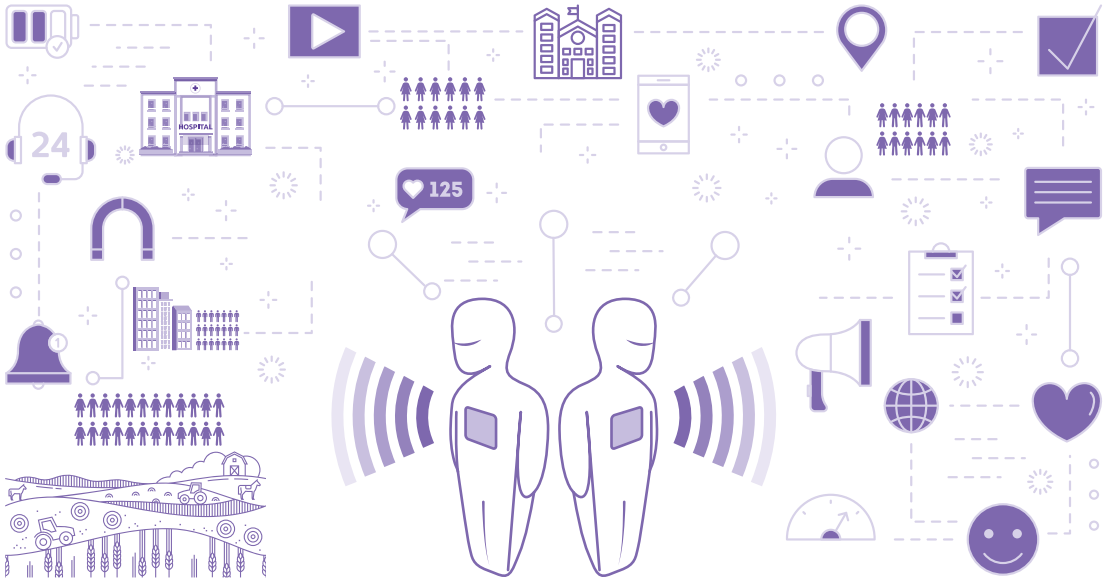
Low-cost, high-quality and high-frequency data collection on child development is feasible in resource-poor environments through a multi-modal approach.

With the technologies used for data collection (including sensors and mobile phones) increasingly available at low cost, the pilot phase of the Child Development Study showed that it is feasible to collect high-frequency, high-quality data related to child health and well-being even in contexts where limited funds and human resources are available.

This requires careful planning to ensure technologies are adapted to local constraints and are widely accepted by the target population; well-designed protocols and survey instruments to avoid fatigue and ensure data quality; the early and sustained involvement of district authorities; and strict adherence to legal and ethical requirements for data collection and use.

Importantly, the strong partnership between the University of Zurich and the University of Malawi's College of Medicine was, and will increasingly be, critical to the study's success, ensuring high-quality training and compliance with data collection guidelines in communities.

High-frequency data collection is:



Good for communities	Good for individuals
• High-frequency monitoring of children's health and their cognitive and socio-emotional development data • Early warning alerts to trigger preventive behaviour at community level • Identifying and treating health threats before their spread	• Combine policy interventions with high-frequency data to personalize nudges for each child • Empower stakeholders to make personalized recommendations for each caregiver

Biomarker data will create an unprecedented body of knowledge on child development in resource-scarce settings.

The pilot confirmed that it is possible to collect ECG and EEG data from children at high frequency – the first ever study in a developing country to test this. By providing a way to monitor biomarkers weekly, along with data collected through other modes, it will eventually be possible to design evidence-based child development interventions, customized to the needs of each child, track their impacts at high frequency, and rapidly change course where and when necessary. Researchers will also enrich the analysis of children's socioemotional development by using EEG and ECG to track children's reactions to stimuli such as images and videos shown on tablets.

Other biomarkers, such as children's respiratory rate and oxygen saturation will be added in the next phase of the Child Development Study. These will provide information on acute respiratory infections, one of the leading cause of death among Malawian children under five years of age.

New avenues for COVID-19 surveillance.

On 2 April 2020, the first case of COVID-19 in Malawi was confirmed. Subsequently, the pandemic spread to every district of the country.

The methods tested by the Child Development Study are a potential means of effective digital surveillance of, and response to, COVID-19 and other communicable diseases, without the risks associated with face-to-face interactions. For example, sensors may be used to track contact patterns and analyse disease spread, while nudges may be used to encourage preventive behaviours such as social distancing and handwashing.

These methods can close the gap between suspected and verified cases, and enable health systems in developing countries to respond quickly and effectively to the spread of infectious diseases.

Sources

This policy brief is based on the inception report of the Child Development Study conducted by College of Medicine University of Zurich's Center for Child Well-Being and Development in partnership with the Government of Malawi, the National Statistical Office, University of Malawi and UNICEF Malawi.

Contact

UNICEF Malawi. www.unicef.org/malawi
Center for Child Well-being and Development. www.ccwd.uzh.ch/
University of Zurich, Department of Economics. www.econ.uzh.ch/en.html

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