

Development of a FHIR Based Application Programming Interface for Aggregate-Level Social Determinants of Health

Suranga N. Kasthurirathne, PhD^{1,2}, Karen F. Corner, MLA³, Neil Devadasan, BEng³, Paul G. Biondich, MD, MS^{1,4}

¹Regenstrief Institute, Indianapolis, IN, USA; ²Fairbanks School of Public Health, Indiana University, Indianapolis, IN, USA; ³Polis Center, Indianapolis, IN, USA; ⁴School of Medicine, Indiana University, Indianapolis, IN, USA

Introduction

Social Determinants of Health (SDH) are defined as ‘the structural determinants and conditions in which people are born, grow, live, work and age’¹. They include an individual’s socio-economic status, education, neighborhood and physical environment, employment, education and access to services². The influence of SDH on an individual’s health status are well established³. Awareness on the value of SDH, as well as the collection of aggregate SDH measured across various geographic areas are on the uptrend. Unfortunately, information infrastructure for accessing and sharing aggregate-level SDH has not progressed in tandem with these advances. Most SDH data are silo’ed by nature, and are available as flat data files that must be manually curated for analytical tasks. Furthermore, there is no established standard for sharing aggregate SDH data. We leveraged the Fast Health Interoperable Resources (FHIR) standard⁴ to model aggregate-level SDH. We partnered with an organization vested in curating aggregate SDH to build a FHIR based Application Programming Interface (API) to communicate aggregate-level SDH for Central Indiana.

Materials and methods

Working with the FHIR community, we modelled the FHIR MeasureReport resource⁵ to represent aggregate SDH. Given that each SDH indicator may be measured at various geographical levels and measurement units, we configured the MeasureReport resource to represent up to 3 geographic levels (block group, census tract and county) and 3 measurement units (summary, ratio and percent). Next, we collaborated with The Polis Center of Indianapolis⁶ a not-for-profit organization that serves as a curator of aggregate-level SDH extracted from multiple sources⁷, to implement a .NET-based Application Programming Interface (API) using the aforementioned FHIR resource. The FHIR API would enable standardized access to the Polis SDH database.

Results

The structure of the FHIR MeasureReport for sharing aggregate-level SDH is presented in Appendix A. The Polis FHIR API developed using FHIR resources consisted of (a) a catalog of over 4,000 SDH indicators obtained from 30 organizations and agencies (Appendix B) and (b) an API that allows users to extract information on a specific SDH indicator for a geographic location identified by an address. Indicators are updated annually or quarterly. Each indicator was measured across multiple geographic levels and measurement units, resulting in multiple results per each query. Where data collected across multiple time periods were available, the API would return only the most recent by default. Additionally, the API could be queried to obtain summary statistics on the availability and variance of specific indicators at county level. These metrics offer researchers a measure of the suitability of each indicator for further study. This information was also modelled in the form of a FHIR resource, but queried using a county identifier instead of a geographic address. Further, all FHIR resources would be available in either XML or JSON format.

Discussion

Our efforts present the first documented effort to leverage a standards-based approach to democratize the use of silo’ed aggregate-level SDH data. The Polis FHIR API offers Medical Record systems the potential to gain programmatic access to aggregate SDH in real time, making it invaluable for a range of tasks from understanding SDH data availability, building composite indicators such as Area Based Deprivation Indices (ADI) as well as leveraging SDH for machine learning based healthcare and population health innovations⁸. Our efforts are relevant to a diverse range of stakeholders and research efforts spread across the healthcare continuum, from clinical research programs such as the Indiana University Precision Medicine Grand Challenge, to entities focused on community health services, social welfare and healthcare policy. Next steps include expanding the Polis FHIR API to support longitudinal and historical SDH retrieval, and strengthening the API by adding logging and authentication facilities to enable easy integration with other online tools/systems.

References

1. Marmot M, Friel S, Bell R, Houweling TA, Taylor S. Closing the gap in a generation: health equity through action on the social determinants of health. *The Lancet*. 2008;372(9650):1661-9.
2. World Health Organization. A conceptual framework for action on the social determinants of health. 2010.
3. Skinner MK. Environmental epigenomics and disease susceptibility. *EMBO reports*. 2011;12(7):620-2.
4. Health Level Seven International. Welcome to FHIR(R) 2017 [Available from: <https://www.hl7.org/fhir/index.html>].
5. Health Level Seven International. Resource MeasureReport 2018 [Available from: <https://www.hl7.org/fhir/measurereport.html>].
6. Polis Center. About us 2018 [Available from: <http://polis.iupui.edu/index.php/about-us/>].
7. Bodenhamer DJ, Colbert JT, Comer KF, Kandris SM. Developing and sustaining a community information system for central Indiana: SAVI as a case study. *Community quality-of-life indicators: Best cases V*: Springer; 2011. p. 21-46.
8. Kasthurirathne SN, Vest JR, Menachemi N, Halverson PK, Grannis SJ. Assessing the capacity of social determinants of health data to augment predictive models identifying patients in need of wraparound social services. *Journal of the American Medical Informatics Association*. 2017 Nov 21;25(1):47-53.

Appendix A. High-level structure of the proposed FHIR MeasureReport resource for reporting aggregate-level SDH

```

<MeasureReport xmlns=http://hl7.org/fhir>
<identifier> <!-- Indicator being reported --> </identifier>
<reportingOrganization><!-- Source of Information--></reportingOrganization>
... <!--Groups to report data as summary, percentage and ratio -->
<group><!--Group that reports indicator data as a Summary -->
  <identifier><value value="Indicator measured as a Summary"/> </identifier>
  <!-- One stratifier per geographic location -->
  <stratifier><identifier><value value="BLKGRP2010"/></identifier>
    <stratum><value value="180973564001"/> <!-- Block Group under study -->
      <measureScore value="301"/> <!-- Numerical value reported -->
    </stratum></stratifier>
  <stratifier><identifier><value value="TRACT2010"/></identifier></stratifier>
  <stratifier><identifier><value value="COUNTY"/></identifier></stratifier>
</group>
<group> <identifier><value value="Indicator measured as a Percentage"/></identifier>
  <!-- Stratum to report by Block group, Census tract and county -->
  ... </group>

<group> <identifier><value value="Indicator measured as a Ratio"/></identifier>
  <!-- Stratum to report by Block group, Census tract and county -->
  ... </group>
</MeasureReport>

```

Appendix B. Subset of data sources contributing to the Polis center, together with geographic extent and granularity of data availability. (MSA = Metropolitan Statistical Area covering 11 Indiana counties, Marion = Marion county only)

Administrative data	# of Indicators	Geographic extent	Block group	Census Tract	School corp.	Zip code	County
US Census Decennial census data	778	MSA	X	X	X		X
US Census community survey	1295	MSA	X	X	X		X
Education data	112				X		X
Home mortgage data	199	MSA		X			X
Housing and Urban Development (HUD) housing data	321	MSA		X			X
Indiana State Dept of Health	33	MSA					X
Marion county vitals data	100	Marion		X	X		
All crime data	80	MSA	X	X	X	X	
Juvenile justice data	67	Marion	X	X	X	X	X
US EPA air quality/emissions data	112	MSA					X