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

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Introduction

Social Determinants of Health (SDH) are defined as ‘the structural determinants and conditions in which people are born, grow, live, work and age’. They include an individual’s socio-economic status, education, neighborhood and physical environment, employment, education and access to services. The influence of SDH on an individual’s health status are well established. 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) standard 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 resource 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 (sum, ratio and percent). Next, we collaborated with The Polis Center of Indianapolis, a not-for-profit organization that serves as a curator of aggregate-level SDH extracted from multiple sources, 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 innovations. 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


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

```xml
<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>
<stratifier><identifier><value value="TRACT2010"/>
</identifier>
<stratifier><identifier><value value="COUNTY"/>
</identifier>
</group>
<group> <!--Stratum to report by Block group, Census tract and county -->
<identifier><value value="Indicator measured as a Percentage"/>
</identifier>
<!-- Stratum to report by Block group, Census tract and county -->
... </group>
<group> <!--Stratum to report by Block group, Census tract and county -->
<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)

<table>
<thead>
<tr>
<th>Administrative data</th>
<th># of Indicators</th>
<th>Geographic extent</th>
<th>Block group</th>
<th>Census Tract</th>
<th>School corp.</th>
<th>Zip code</th>
<th>County</th>
</tr>
</thead>
<tbody>
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<td>MSA</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<tr>
<td>US Census community survey</td>
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<td>X</td>
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<tr>
<td>Education data</td>
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<td>Home mortgage data</td>
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<tr>
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<tr>
<td>Indiana State Dept of Health</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>All crime data</td>
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<td>Juvenile justice data</td>
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<td>Marion</td>
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<td>X</td>
</tr>
<tr>
<td>US EPA air quality/emissions data</td>
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<td>MSA</td>
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<td></td>
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<td>X</td>
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