

### 3. MEDICAL VULNERABILITY

#### Background

Research over the past two decades from epidemiology and public health has investigated the link between health and social vulnerability, drawing ties from the social science literature to identify the social characteristics of populations at highest health risk based on access to medical resources (Aday, 1994 and 2001). These commonly cited social characteristics that correlate with health care access include social status, social capital, and human capital; showing unmistakable parity with those social indicators introduced by the social vulnerability literature in the previous section. Several researchers, however, make a clear distinction between health risk and health need (Aday, 1994 and 2001; Morath, 2010). While the social indicators of health risk help to identify sensitive populations, the indicators of health need identify individuals and communities with inherent medical vulnerability, independent of ancillary factors.

While the concept of medical vulnerability is relatively new in the field of hazards research, it is tenured in a long-standing tradition combining concepts of public and environmental health, quality of life, health equity, medical surge, and other place-based models of community and family health. Based on the epidemiology and disaster surveillance literature, Morath's (2010) investigation of medical vulnerability to disasters identifies three dimensions that contribute to a potential for harm: individual medical needs, community healthcare access, and health system capability. These dimensions, described in Table 10, are derived not only from direct disaster impacts on the exposed population, but also from impacts on the healthcare system that include the interruption of key medical services.

Table 10: Medical vulnerability concepts and description.

Population Characteristic and Specific Variables	Influence on Medical Vulnerability
<p><b>Healthcare access</b></p> <ul style="list-style-type: none"> <li>County level medically underserved areas</li> <li>Tract level medically underserved areas</li> <li>County level medically underserved populations</li> <li>Tract level medically underserved populations</li> <li>County level mental health practitioner shortage areas</li> <li>Zip code level mental health practitioner shortage areas</li> <li>Tract level mental health practitioner shortage areas</li> <li>County level primary health practitioner shortage areas</li> <li>Tract level primary health practitioner shortage areas</li> <li>Zip code level non-emergency access to geriatric medical specialists</li> <li>Zip code level non-emergency access to emergency medical specialists</li> <li>Zip code level non-emergency access to obstetric medical specialists</li> <li>Zip code level non-emergency access to pediatric medical specialists</li> <li>Zip code level non-emergency access to primary medical specialists</li> <li>Tract level non-emergency access to federally qualified health centers</li> <li>Tract level non-emergency access to Hill Burton<sup>21</sup> facilities</li> </ul>	<p>Individuals or communities with limited access to healthcare resources, either through direct local scarcity of healthcare providers or through financial proxies, such as insurance status.</p>

<sup>21</sup> Free and Reduced-Cost Health Care - <http://www.hrsa.gov/gethealthcare/affordable/hillburton/>

<p>Tract level non-emergency access to rural health centers  Tract level access to emergency medical transport services  Tract level non-emergency access to county health clinics  Tract level non-emergency access to free health clinic</p>	
<p><b>Health System Capability</b></p> <p>County level community emergency response team (CERT) capacity  Zip code level community emergency response team (CERT) capacity  County level funding of non-profit health care organizations  County level home health facility capacity  County level homemaker and companion service facilities  Tract level interventional cardiac capability  Tract level stroke care capability  Tract level pediatric trauma capability  Tract level emergency maternity capability  Tract level trauma level 1 or level 2 capability  Tract level emergency mental health capability  Tract level emergency hospital capability  Tract level emergency burn service capability</p>	<p>Resources maintained by the local healthcare system that prepare for emergencies and help to build medical surge capacity during disasters.</p>
<p><b>Medical needs</b></p> <p>County level percentage of uninsured populations  County level percentage of Medicaid recipients  County level percentage of developmentally disabled populations  County level percentage of seriously emotionally disturbed children  County level percentage of adults with serious mental illness  County level percentage of oxygen dependent populations  County level percentage of adults with probable Alzheimer's Disease  County level percentage of elders (age 65+) living alone  County level percentage of person's reporting poor overall health  County level percentage of diabetic populations  Zip code level percentage of dialysis patients  County level percentage of adults with chronic heart disease  County level percentage of adults with hypertension  County level percentage of adults with asthma  County level percentage of adults with debilitating arthritis  County level percentage of low birth weight babies  County level per capita number of violent crimes  County level per capita number of domestic crimes  County level perception of access to medical care  County level perception of medical care quality  Zip code level of water borne communicable diseases  Zip code level of OASDI beneficiaries  Zip code level percentage of brain and spinal cord injuries  Zip code level percentage of pregnant mothers enrolled in WIC program  Zip code level percentage of children's medical service patients  County level per capita number of nursing home beds  County level per capita number of assisted living beds  County level per capita number of hospice facilities</p>	<p>Individuals dependent on the public healthcare system for medication, medical treatment, equipment, or supervision from skilled medical professionals to maintain quality of health and life.</p> <p>Individuals with psychological or psychosomatic disorders, or having mental limitations that often require medical consideration including medication, therapy, supervision, and in some acute cases institutionalization.</p>

## Methods

Despite a well-developed understanding of public health and wellbeing indicators, quantification of community health remains a major challenge, due in part to the insufficiency and confidentiality of health incidence data. In 2010, Morath developed the Medical Vulnerability Index (MedVI), borrowing the algorithmic approach finalized by Cutter et al. (2003) for the construction of the SoVI. Morath's (2010) MedVI used principal components analysis to derive a multidimensional construct of social vulnerability, comprised by the concepts reviewed in the table above. Identifying appropriate data for quantifying medical vulnerability across that state was the first step necessary to create a spatial representation of the theoretical framework. For this project, we relied heavily on previous work undertaken by Morath (2010) as a basis from which to build the current MedVI dataset. Included in Morath's work were 36 variables identified through a detailed literature review and expert identification provided by the Florida Department of Health as indicators or representations of medically vulnerable populations across the state (FLDOH Key Indicators; FDOH 2012). These indicators provided a solid starting point for the data collection described in this work.

In the progression of this research design, our variant of the MedVI includes a number of key modifications to Morath's original work, including:

1. An expanded set of indicators, including 61 discrete variables that capture MedVI at multiple scales to comprehensively capture spatial variations.
2. Utilization of a tenured subject matter expert on the project team to guide us in sometimes unfamiliar territory
3. Departure from the principle components analysis utilized by Morath in favor of a method that is more easily dissectible and readily applicable to planning and decision analytics

The variables, selection criteria, processing steps, and analytic procedures used in this section are outlined in a detailed technical appendix following the results. Generally, however, variables were chosen for inclusion in this project if they met one or more of the following criteria.

- Previous identification of a variable as characteristic of medically vulnerable populations by the Florida Department of Health.
- Variables utilized in the previous work by Morath in the first iteration of MedVI for Florida.
- Variables related to high risk health concerns (e.g., heart disease, low birth rate).
- Crime information related to possible delays in medical response following a disaster.
- Perceptions of health quality, health care access, and indicators of areas that have historically been medically underserved or have shortages of practitioners.
- Locations with higher than average numbers of persons who will require special attention or special medical assistance during a disaster.
- Characteristics of communities that lead to higher levels of capacity to respond to a disaster.

- Indicators of decreased access to health care resources.

## Results and Findings

The pattern of MedVI across the state is varied, with the highest scores generally located in rural areas and in counties that are more rural (Figure 4). However, this image can be a bit misleading because there are many urbanized areas within the state that also have high MedVI but are such small census tracts that they are not easily identifiable on the maps below. Table 11 shows the number of census tracts in each MedVI standard deviation class. This method permits the best balance between interpretation (3 classes) and the identification and visualization of the extremes (high and low vulnerability that are of the most interest). Here, one can gain a more robust understanding of the pattern of MedVI within and between counties than is comprehensible by simply looking at the maps. The table helps us to identify many instances where there are significant numbers of tracts with high MedVI classification that may be too small to identify on a map. For example, Brevard County has 27 tracts and Hillsborough County has 85 tracts with high MedVI scores that are not immediately recognizable on the map. Table 12 provides information on the total populations residing within each of these census tracts based on their assigned medical vulnerability. This table provides a higher level of aggregation for counties and the state as a whole but also supports a finer level of sub-county assessment.

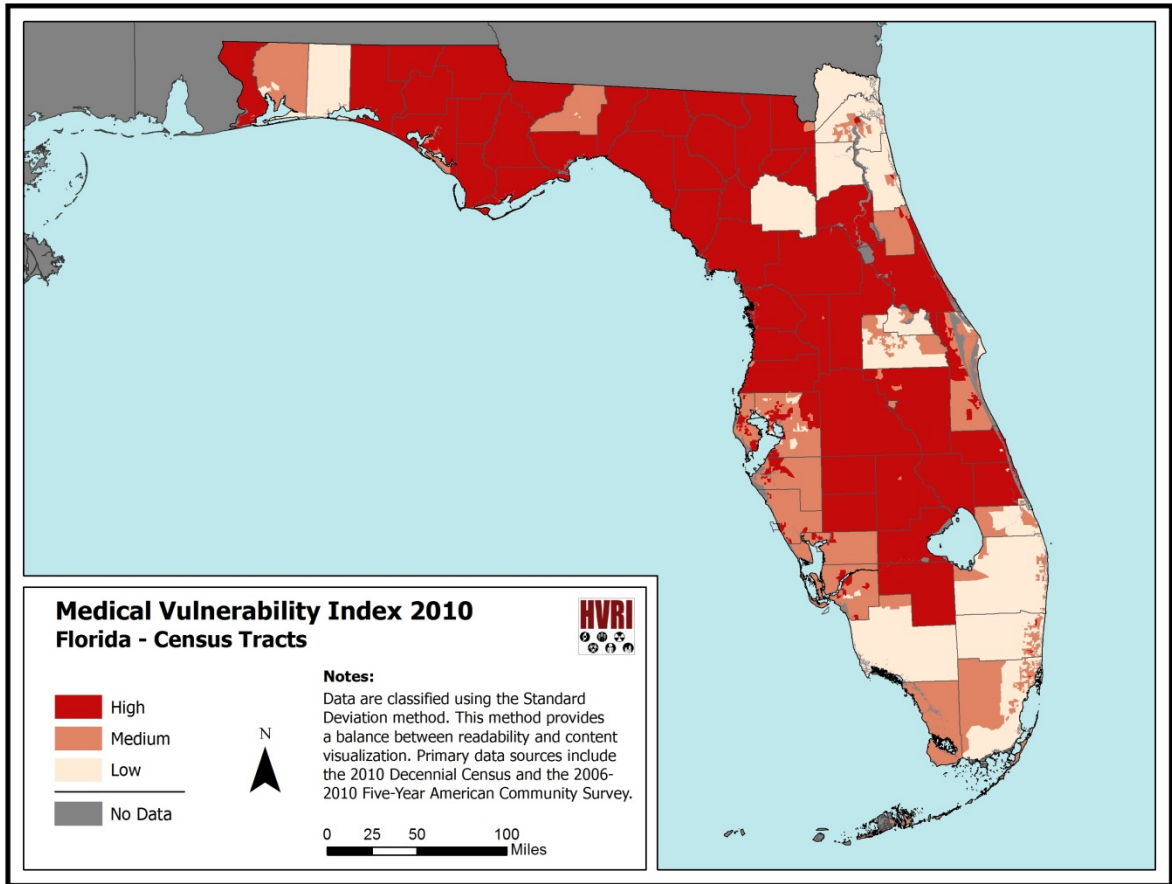


Figure 4: MedVI for census tracts within the state of Florida.

Table 11: Census tract summary of MedVI standard deviation classification by county.

County Name	Medical Vulnerability Index			County Name	Medical Vulnerability Index		
	High	Medium	Low		High	Medium	Low
Alachua	-	-	100.00%	Lee	19.28%	78.92%	1.81%
Baker	75.00%	25.00%	-	Leon	-	95.59%	4.41%
Bay	74.42%	25.58%	-	Levy	100.00%	-	-
Bradford	100.00%	-	-	Liberty	100.00%	-	-
Brevard	23.89%	74.34%	1.77%	Madison	100.00%	-	-
Broward	1.11%	28.25%	70.64%	Manatee	21.79%	78.21%	-
Calhoun	100.00%	-	-	Marion	98.41%	-	1.59%
Charlotte	18.42%	81.58%	-	Martin	-	35.29%	64.71%
Citrus	96.43%	-	3.57%	Miami-Dade	0.77%	33.78%	65.44%
Clay	-	-	100.00%	Monroe	-	96.67%	3.33%
Collier	-	6.85%	93.15%	Nassau	-	-	100.00%
Columbia	100.00%	-	-	Okaloosa	-	-	100.00%
DeSoto	100.00%	-	-	Okeechobee	100.00%	-	-
Dixie	100.00%	-	-	Orange	-	31.40%	68.60%
Duval	5.78%	34.68%	59.54%	Osceola	95.12%	4.88%	-
Escambia	98.59%	1.41%	-	Palm Beach	-	16.96%	83.04%
Flagler	30.00%	70.00%	-	Pasco	98.50%	1.50%	-
Franklin	100.00%	-	-	Pinellas	27.87%	71.72%	0.41%
Gadsden	100.00%	-	-	Polk	99.35%	0.65%	-
Gilchrist	100.00%	-	-	Putnam	100.00%	-	-
Glades	100.00%	-	-	Santa Rosa	-	52.00%	48.00%
Gulf	100.00%	-	-	Sarasota	17.02%	82.98%	-
Hamilton	100.00%	-	-	Seminole	-	13.95%	86.05%
Hardee	100.00%	-	-	St. Johns	5.13%	12.82%	82.05%
Hendry	100.00%	-	-	St. Lucie	97.73%	-	2.27%
Hernando	100.00%	-	-	Sumter	94.74%	5.26%	-
Highlands	96.30%	3.70%	-	Suwannee	100.00%	-	-
Hillsborough	26.65%	64.89%	8.46%	Taylor	100.00%	-	-
Holmes	100.00%	-	-	Union	100.00%	-	-
Indian River	96.67%	-	3.33%	Volusia	100.00%	-	-
Jackson	100.00%	-	-	Wakulla	100.00%	-	-
Jefferson	100.00%	-	-	Walton	100.00%	-	-
Lafayette	100.00%	-	-	Washington	100.00%	-	-
Lake	100.00%	-	-	<b>State Total</b>	<b>30.80%</b>	<b>33.35%</b>	<b>35.85%</b>

Table 12: Census tract summary of population by MedVI standard deviation classification by county.

County Name	Medical Vulnerability Index			County Name	Medical Vulnerability Index		
	High	Medium	Low		High	Medium	Low
Alachua	-	-	247,336	Lee	136,588	478,225	3,941
Baker	20,431	6,684	-	Leon	-	265,689	9,798
Bay	127,796	41,056	-	Levy	40,801	-	-
Bradford	28,520	-	-	Liberty	8,365	-	-
Brevard	158,238	385,131	-	Madison	19,224	-	-
Broward	27,116	530,018	1,190,932	Manatee	73,525	249,308	-
Calhoun	14,625	-	-	Marion	331,298	-	-
Charlotte	32,234	127,744	-	Martin	-	56,055	90,263
Citrus	141,236	-	-	Miami-Dade	12,514	937,344	1,543,269
Clay	-	-	190,865	Monroe	-	73,070	20
Collier	-	24,417	297,103	Nassau	-	-	73,314
Columbia	67,531	-	-	Okaloosa	-	-	180,822
DeSoto	34,862	-	-	Okeechobee	39,996	-	-
Dixie	16,422	-	-	Orange	-	371,439	774,517
Duval	34,821	264,174	565,268	Osceola	264,577	4,108	-
Escambia	294,396	3,223	-	Palm Beach	-	231,220	1,088,242
Flagler	24,521	71,175	-	Pasco	458,710	5,987	-
Franklin	11,549	-	-	Pinellas	272,992	641,881	1,669
Gadsden	46,389	-	-	Polk	602,092	3	-
Gilchrist	16,939	-	-	Putnam	74,364	-	-
Glades	12,884	-	-	Santa Rosa	-	73,996	77,376
Gulf	15,863	-	-	Sarasota	63,596	315,852	-
Hamilton	14,799	-	-	Seminole	-	33,476	389,242
Hardee	27,731	-	-	St. Johns	7,673	18,182	164,184
Hendry	39,140	-	-	St. Lucie	277,789	-	-
Hernando	172,778	-	-	Sumter	87,023	-	-
Highlands	98,785	1	-	Suwannee	41,551	-	-
Hillsborough	307,926	849,989	71,311	Taylor	22,570	-	-
Holmes	19,927	-	-	Union	15,535	-	-
Indian River	138,028	-	-	Volusia	494,593	-	-
Jackson	49,746	-	-	Wakulla	30,776	-	-
Jefferson	14,761	-	-	Walton	55,043	-	-
Lafayette	8,870	-	-	Washington	24,896	-	-
Lake	297,052	-	-	<b>State Total</b>	<b>5,772,007</b>	<b>6,059,447</b>	<b>6,959,472</b>

Overall, medical vulnerability is comprised by a multitude of factors that can be categorized into three broad categories:

1. Health Care Access
2. Health Care System Capability
3. Medical Need

Each of these broad categories was developed based upon how the component parts (variables) are seen in relation to the concept of social vulnerability described above. Every variable was appraised based on how it either added to or diminished overall



MedVI and how it characterized the populations or capacities within the state. Each of these broad categories is discussed in detail below.

### Health Care Access

The first of the three categories utilized in the creation of this MedVI index centers on the identification of locations and populations within the state of Florida with less than adequate access to medical care. Lack of access or inadequate access to medical treatment facilities, physicians, emergency medical care, and primary medical treatment increases MedVI. Understanding where people are located and identifying service area gaps and medical treatment shortages linked to those locations provides a useful “picture” of areas where planning, decision-making, and resource allocation may help not only during but also in non-disaster times. To that end we identified, normalized, standardized, and mapped the following component pieces:

- County level medically underserved areas
- Tract level medically underserved areas
- County level medically underserved populations
- Tract level medically underserved populations
- County level mental health practitioner shortage areas
- Zip code level mental health practitioner shortage areas
- Tract level mental health practitioner shortage areas
- County level primary health practitioner shortage areas
- Tract level primary health practitioner shortage areas
- Zip code level non-emergency access to geriatric medical specialists
- Zip code level non-emergency access to emergency medical specialists
- Zip code level non-emergency access to obstetric medical specialists
- Zip code level non-emergency access to pediatric medical specialists
- Zip code level non-emergency access to primary medical specialists
- Tract level non-emergency access to federally qualified health centers
- Tract level non-emergency access to Hill Burton facilities
- Tract level non-emergency access to rural health centers
- Tract level access to emergency medical transport services
- Tract level non-emergency access to county health clinics
- Tract level non-emergency access to free health clinic

### Health Care System Capability

The second major component of medical vulnerability that is a requisite part for understanding how a place or population may be differentially impacted by disasters is the functional capabilities present within the health care system. Here, we aim to identify and spatially display differences in county and community ability to assist populations residing within their respective jurisdictions. This portion of the assessment focuses on a host of medical vulnerability variables directly connected to fostering efficient and effective response to disasters and medical events. Included here are:

- County level community emergency response team (CERT) capacity
- Zip code level community emergency response team (CERT) capacity



- County level funding of non-profit health care organizations
- County level home health facility capacity
- County level homemaker and companion service facilities
- Tract level interventional cardiac capability
- Tract level stroke care capability
- Tract level pediatric trauma capability
- Tract level emergency maternity capability
- Tract level trauma level 1 or level 2 capability
- Tract level emergency mental health capability
- Tract level emergency hospital capability
- Tract level emergency burn service capability

### Medical Need

The third tenet of medical vulnerability centers on population health and the identification of characteristics that often combine to create adverse situations for at risk populations. This portion of the assessment aims to identify and spatially quantify a host of characteristics related to poor health for the state. Understanding the spatial variations in underlying medical need will provide the baseline information needed to adequately plan for extreme hazard events. This section specifically identifies health indicators that are known to either put people at risk during a disaster or (in combination) create a more vulnerable population group. To this end, we analyzed the following medical need characteristics:

- County level percentage of uninsured populations
- County level percentage of Medicaid recipients
- County level percentage of developmentally disabled populations
- County level percentage of seriously emotionally disturbed children
- County level percentage of adults with serious mental illness
- County level percentage of oxygen dependent populations
- County level percentage of adults with probable Alzheimer's Disease<sup>22</sup>
- County level percentage of elders (age 65+) living alone
- County level percentage of person's reporting poor overall health
- County level percentage of diabetic populations
- Zip code level percentage of dialysis patients
- County level percentage of adults with chronic heart disease
- County level percentage of adults with hypertension
- County level percentage of adults with asthma
- County level percentage of adults with debilitating arthritis
- County level percentage of low birth weight babies
- County level per capita number of violent crimes
- County level per capita number of domestic crimes
- County level perception of access to medical care
- County level perception of medical care quality
- Zip code level of water borne communicable diseases
- Zip code level sum of (Old Age, Survivors And Disability Insurance Program) - OASDI beneficiaries

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<sup>22</sup> [http://www.floridacharts.com/Charts/documents/VP\\_Data\\_Sources.pdf](http://www.floridacharts.com/Charts/documents/VP_Data_Sources.pdf)

- Zip code level percentage of brain and spinal cord injuries
- Zip code level percentage of pregnant mothers enrolled in WIC program
- Zip code level percentage of children's medical service patients
- County level per capita number of nursing home beds
- County level per capita number of assisted living beds
- County level per capita number of hospice facilities

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