Health-Related Social Needs Following Onset of the COVID-19 Pandemic in Oregon

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VISUAL ABSTRACT

ABSTRACT

PURPOSE Efforts during the COVID-19 pandemic to address the health-related social needs (HRSN) of Medicare and Medicaid beneficiaries, such as food and housing, were insufficient. We examined HRSN data from the Accountable Health Communities study collected in Oregon to understand changes in these needs at the onset and during the first 2 years of the pandemic.

METHODS We conducted an interrupted time series analysis with data from 21,522 Medicare and Medicaid beneficiaries screened for overall HRSN between May 13, 2019 and December 24, 2021. Secondary interrupted time series analyses were conducted for each type of HRSN assessed with the Accountable Health Communities screening tool: food, housing, transportation, utilities, and interpersonal safety.

RESULTS The interrupted time series analysis indicated an abrupt 17.7–percentage point increase in overall HRSN around March 23, 2020, which did not significantly decline during the subsequent 2 years. Food, housing, and interpersonal safety needs increased by 16.5, 15.9, and 4.4 percentage points, respectively, with no significant decline thereafter. Transportation and utility needs increased by 7.2 and 7.5 percentage points, respectively, but decreased significantly after the start of the pandemic (decreasing by 0.2 and 0.1 percentage points each week, respectively).

CONCLUSIONS The jump in HRSN following the start of the pandemic and the persistence of need, particularly in food and housing, highlight the importance of research to better understand which public health and health care interventions, investments, and policies effectively address HRSN.

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INTRODUCTION

It is widely accepted that health-related social needs (HRSN), such as food, housing, and transportation, play a critical role in overall health and well-being.[1,2] The COVID-19 pandemic amplified HRSN disparities,[3-6] added stress to social service delivery systems,[7-9] and further fueled the urgency to understand and address these needs. To explore how HRSN changed during the COVID-19 pandemic, we analyzed data collected in Oregon for the Accountable Health Communities (AHC) study.

The AHC study was launched by the Centers for Medicare & Medicaid Services (CMS) to test the effects of systematic HRSN screening and social services navigation on health outcomes and costs.[10] Nationally, from 2018 through 2022, more than 1 million beneficiaries were screened by AHC grantees in primary care, behavioral health, and emergency department settings.[11] The COVID-19 pandemic began slightly more than a year after screening for AHC started. On March 23, 2020, Oregon's governor declared a stay-at-home order.[12]

We conducted an interrupted time series (ITS) analysis of cross-sectional AHC data collected at all participating Oregon sites from 1 year before through 2 years after the stay-at-home order to estimate the overall increase in HRSN during the COVID-19 pandemic. Additionally, we conducted secondary ITS analyses to explore trends in the specific types of HRSN captured by the AHC screening tool. We hypothesized that HRSN reporting would spike at the time of the stay-at-home order and decrease toward prepandemic levels as federal and state emergency social services were deployed.

Conflicts of interest authors report none.

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METHODS

To address the primary question, "How have HRSN changed since COVID-19 began for Oregon Medicare and Medicaid beneficiaries?" we used ITS analysis, which is widely considered to be one of the strongest quasi-experimental methods[13-16] and minimizes selection bias and confounding.[17] ITS has been used in a number of studies of population health,[18-20] including studies examining impacts of the COVID-19 pandemic.[21-23] An ITS model was used to test the hypothesis that there was an immediate change in overall reporting of HRSN following Oregon's stay-at-home order (a proxy for the "intervention" of the COVID-19 pandemic in the model), as well as a change in the trend of reported HRSN among Oregon Medicare and Medicaid beneficiaries after that date. We then conducted secondary ITS analyses to look at changes over time for each of the 5 types of HRSN reported.

The Oregon Health & Science University Institutional Review Board approved the AHC study on July 17, 2018 (IRB No. STUDY00018168).

AHC Screening in Oregon

We collected HRSN data using all core questions from the AHC screening tool, which includes questions on 5 primary areas of need: food, housing, transportation, utilities, and interpersonal safety.[10] The tool compiles questions from validated screening instruments that were selected by a Technical Expert Panel convened by CMS.[10] The Oregon Rural Practice-based Research Network (ORPRN), a statewide network of rural and urban health care partners, was funded by CMS to administer the tool to Medicare and Medicaid beneficiaries.[24-26] Approximately 70% of the Oregon population receives care in an ORPRN-affiliated site. The AHC was a cross-sectional study that included universal screening of all Medicare and Medicaid beneficiaries during clinical visits. To be eligible for the study, beneficiaries needed to be enrolled in Medicare and/or Medicaid at the time of their clinical visit and be seen in 1 of the 50 participating sites. Screened beneficiaries resided in 27 of Oregon's 36 counties, including urban, rural, and remote regions. With the start of the pandemic, CMS allowed telephone and secure text screening after visits and, in an effort to support AHC sites and reduce selection bias, ORPRN study staff took over most of the screening on behalf of sites.

Study Sample

The study sample was limited to community-dwelling Oregon Medicare and Medicaid beneficiaries screened between May 13, 2019 and December 24, 2021 (inclusive). If an individual was screened more than once during the study period, only 1 screen was included in the analysis, using the following criteria: (1) if an individual indicated at least 1 HRSN on any screen, we retained the first screen wherein the individual indicated HRSN in order to approximate the time at which the need first appeared, or (2) if an individual did not indicate any HRSN on any screens, we randomly selected a single screen, balanced across periods (before vs after the stay-at-home order) to reduce the chance of bias toward "no HRSN" for either period.

Statistical Analyses

For the primary analysis, the outcome variable was the proportion of individuals who reported at least 1 HRSN, aggregated by week. We tested both a change in level and a change in

Table 1. Participant Characteristics

Characteristic	All (N = 21,522)	Relative to Stay-at-Home Order[a]		
		Before (n = 8,234)	After (n = 13,288)	*P* Value
Age group, No. (%)				<.001
≤17 years	3,157 (15)	1,375 (17)	1,782 (13)	
18-64 years	10,807 (50)	3,199 (39)	7,608 (57)	
≥65 years	7,558 (35)	3,660 (44)	3,898 (29)	
Gender, No. (%)				<.001
Female	12,668 (59)	5,154 (63)	7,514 (57)	
Male	8,202 (38)	3,067 (37)	5,135 (39)	
Unknown	652 (3)	13 (<1)	639 (5)	
Residence, No. (%)				<.001
Urban	13,711 (64)	3,636 (44)	10,075 (76)	
Rural	7,453 (35)	4,554 (55)	2,899 (22)	
Frontier	285 (1)	11 (<1)	274 (2)	
Unknown	73 (<1)	33 (<1)	40 (<1)	
Medicaid beneficiary, No. (%)				<.001
Yes	15,705 (73)	5,391 (65)	10,314 (78)	
No	5,817 (27)	2,843 (35)	2,974 (22)	
Race, No. (%)				<.001
American Indian or Alaska Native ± White	797 (4)	329 (4)	468 (4)	
Asian ± White	370 (2)	111 (1)	259 (2)	
Black ± White	1,056 (5)	246 (3)	810 (6)	
Native Hawaiian or other Pacific Islander ± White	158 (1)	37 (<1)	121 (1)	
White only	14,589 (68)	6,318 (77)	8,271 (62)	
Other only	1,147 (5)	250 (3)	897 (7)	
Combination of ≥2 races not listed above	290 (1)	81 (1)	209 (2)	
Unknown	3,115 (14)	862 (10)	2,253 (17)	
Ethnicity, No. (%)				<.001
Hispanic or Latino/a/x	3,181 (15)	889 (11)	2,292 (17)	
Not Hispanic or Latino/a/x	14,854 (69)	6,355 (77)	8,499 (67)	
Unknown	3,487 (16)	990 (12)	2,497 (19)	

[a] Before: the 1 year before the stay-at-home order. After: the 2 years after the stay-at-home order.

slope (trend) at the date of Oregon's stay-at-home order (Executive Order 20-12), March 23, 2020,[12] which was considered the "intervention" in the ITS model. For the secondary analyses, the outcome variable was the proportion of individuals who screened positive for each of the 5 HRSN types assessed by the AHC screening tool: food, housing, transportation, utilities, and interpersonal safety.

We used R version 4.4.0 (R Foundation for Statistical Computing) for all data management, analysis, and figures. Additional information regarding analyses is available in the Supplemental Appendix.

Table 2. Changes in HRSN, Overall and by Type: Interrupted Time Series Models

Model and Time Period[a]	Coefficient Estimate (SE)	95% CI	*t* Value	*P* Value
Primary model: overall HRSN				
Before	0.3974 (0.02011)	0.3576 to 0.4372	19.77	<.001
Trend before	<0.0001 (0.00074)	–0.0014 to 0.0015	0.05	.96
Stay-at-home order	0.1774 (0.02353)	0.1309 to 0.2240	7.54	<.001
Trend after	0.0006 (0.00079)	–0.0021 to 0.0010	–0.74	.46
Secondary models				
HRSN: food				
Before	0.2909 (0.01815)	0.2550 to 0.3268	16.03	<.001
Trend before	–0.0007 (0.00067)	–0.0021 to 0.0006	–1.09	.28
Stay-at-home order	0.1651 (0.02125)	0.1231 to 0.2071	7.77	<.001
Trend after	–0.0004 (0.00071)	–0.0018 to 0.0010	–0.55	.58
HRSN: housing				
Before	0.2131 (0.01824)	0.1771 to 0.2492	11.68	<.001
Trend before	–0.0009 (0.00068)	–0.0022 to 0.0004	–1.34	.18
Stay-at-home order	0.1589 (0.02136)	0.1167 to 0.2011	7.44	<.001
Trend after	0.0013 (0.00072)	–0.0001 to 0.0027	1.84	.07
HRSN: transportation				
Before	0.0916 (0.01536)	0.0612 to 0.1219	5.96	<.001
Trend before	0.0018 (0.00057)	0.0006 to 0.0029	3.09	.002
Stay-at-home order	0.0724 (0.01798)	0.0368 to 0.1080	4.03	<.001
Trend after	–0.0024 (0.00060)	–0.0035 to –0.0012	–3.90	<.001
HRSN: utilities				
Before	0.0883 (0.01108)	0.0664 to 0.1102	7.97	<.001
Trend before	0.0003 (0.00041)	-0.0005 to 0.0012	0.85	.40
Stay-at-home order	0.0746 (0.01297)	0.0490 to 0.0100	5.75	<.001
Trend after	-0.0009 (0.00044)	-0.0018 to -0.0001	–2.12	.04
HRSN: interpersonal safety				
Before	0.0291 (0.00503)	0.0191 to 0.0390	5.78	<.001
Trend before	–0.0003 (0.00019)	–0.0006 to 0.0001	–1.39	.17
Stay-at-home order	0.0442 (0.00589)	0.0326 to 0.0559	7.51	<.001
Trend after	–0.0001 (0.00020)	–0.0005 to 0.0002	–0.62	.54

HRSN = health-related social needs; SE = standard error.

[a] Before: level before the stay-at-home order (intercept, time zero); trend before: change in slope in the 1 year before order; stay-at-home order: change in level at the time of the order; trend after: change in slope in the 2 years after order.

RESULTS

Participant Characteristics

A total of 21,522 unique Medicare and Medicaid beneficiaries participated in the AHC in Oregon between May 13, 2019 and December 24, 2021: 8,234 before and 13,288 after the March 23, 2020 stay-at-home order. The number of screens for any given week ranged from 34 to 385.

Both before and after the stay-at-home order, there were more female than male screened beneficiaries (63% female before, 57% female after), and between two-thirds and three-quarters of the study sample identified as White-only (77% White before, 62% after) and not Hispanic or Latino/a/x (77% not Hispanic or Latino/a/x before, 67% after) (Table 1). The pre-order period had a higher percentage who were aged 65 years or older compared with the post-order period (44% and 29%, respectively). There was also a larger percentage of those who declined to report race and ethnicity after the stay-at-home order (10% unknown race before, 17% after; 12% unknown ethnicity before, 19% after). The percentage of urban screened beneficiaries was also higher after the order (44% before, 76% after), as was the percentage of those insured by Medicaid (65% before, 78% after).

Primary ITS Analysis: Overall HRSN

Overall, 39.7% of screened beneficiaries (95% CI, 35.8%-43.7%) had at least 1 HRSN before the stay-at-home order (Table 2). The proportion having HRSN among those screened increased by 17.7 percentage points (95% CI, 13.1-22.4 percentage points; P <.001) after the stay-at-home order. There was neither a significant trend in the proportion having HRSN in the year before the order (P = .96), nor a significant change in trend in the 2 years after the order (P = .46). These results indicate an abrupt increase in HRSN at the time of the stay-at-home order that did not decrease significantly over the study period (Figure 1).

Secondary ITS Analysis: Types of HRSN

Food was the most reported HRSN before the stay-at-home order (Table 2 and Figure 2). Fully 29.1% of screened beneficiaries indicated food insecurity during the prepandemic period, with no significant trend over time. This estimate increased by 16.5 percentage points at the time of the order (P <.001). The proportion reporting food insecurity decreased slightly over the subsequent 2 years, but the trend was nonsignificant (P = .58).

Likewise, housing was reported as an HRSN for 21.3% of screened beneficiaries during the prepandemic period and the proportion increased by 15.9 percentage points at the time of the stay-at-home order. Although no significant trend was detected either before or after the stay-at-home order ($P = .18$ and $P = .07$, respectively), scatterplots indicated a possible increase over time after the order for housing, whereas other types of HRSN appeared to be decreasing slightly over time.

Transportation was an HRSN for 9.2% of screened beneficiaries before the stay-at-home order. This need increased by 1.8 percentage points each week before the order ($P = .002$), increased by 7.2 percentage points at the time of the order ($P < .001$), and then decreased by 0.2 percentage points each week after the order ($P < .001$), indicating a trend toward prepandemic levels within the study period.

Utilities were an HRSN for 8.8% of screened beneficiaries before the stay-at-home order. There was no significant trend for utilities before the order ($P = .40$). This need increased by 7.5 percentage points at the time of the order ($P < .001$) and then decreased by 0.1 percentage points each week after the order ($P = .04$), indicating a trend toward prepandemic levels within the study period.

Interpersonal safety was reported the least frequently, by 2.9% of screened beneficiaries before the stay-at-home order. This need increased by 4.4 percentage points at the time of the order ($P < .001$), with no significant trend either before or after the order ($P = .17$ and $P = .54$, respectively).

DISCUSSION

Our findings indicate HRSN among Medicare and Medicaid beneficiaries increased precipitously after the onset of the COVID-19 pandemic and stayed at levels substantially higher than they were prepandemic. The rapid 17.7–percentage point population increase in HRSN reported, and its persistence in the year after Oregon's COVID-19 stay-at-home order, may point to a need for increased and improved approaches to addressing HRSN. This immediate and persistent need, despite substantially increased public and private spending and supportive policies, such as increased unemployment assistance and eviction moratoriums,[27] is indicative of the fragility of our social service delivery systems.

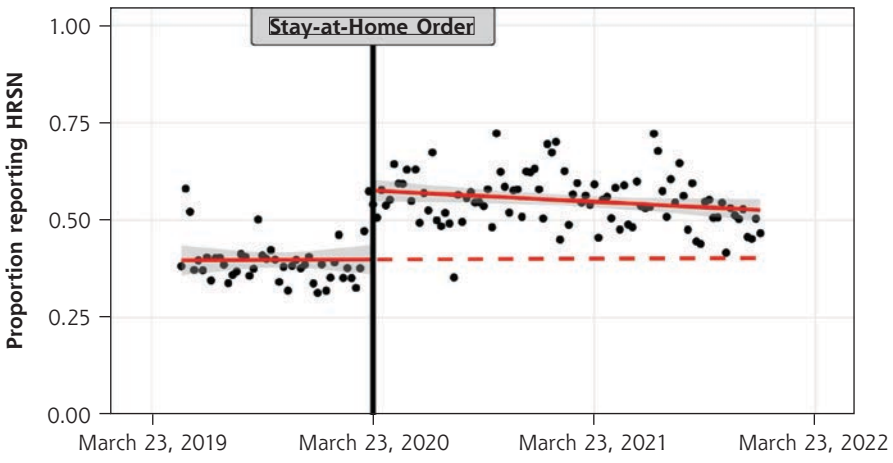
It is particularly notable that food and housing insecurity increased dramatically (by 16.5 and 15.9 percentage points, respectively) and persisted at a much higher level of need for nearly 2 years beyond issuance of the stay-at-home order. Interpersonal safety, although reported by only about 3% of screened beneficiaries before the order, increased by 4.4 percentage points after the order. And although no significant trend in housing need after the stay-at-home order was evident in our data ($P = .07$), scatterplots and estimates suggest a possible increase in housing need from the time of the order through the end of our study period. Additional research is needed to explore the longevity of the COVID-19 pandemic's impact on HRSN, especially among Medicare and Medicaid beneficiaries.

Oregon policy makers, Medicaid Accountable Care Organizations—called Coordinated Care Organizations (CCOs) in Oregon—and clinics have taken steps since the pandemic to address the greater level of HRSN. This has included instituting a new CCO "social determinants of health" incentive metric requiring annual screening for food, housing, and transportation needs, and navigation to HRSN resources for all Medicaid beneficiaries.[28] CCOs have also maintained higher spending levels on HRSN through voluntary Health-Related Services investments.[29] Also, many Oregon AHC sites have continued HRSN screening and navigation.

Although there is broad awareness of HRSN and the impact of the pandemic on populations affected by ongoing structural marginalization, particularly racially and ethnically minoritized populations,[4] the magnitude and persistence of the increase in HRSN may not be widely understood. This may result in underinvestment in HRSN at a societal level and insufficient involvement of all sectors in addressing these needs.

The AHC model coincided with an unprecedented time in history that made this analysis possible and also contributed to its limitations. Ideally, we would have 2 or more years of HRSN data before the stay-at-home order to detect and adjust for yearly seasonality that may be present in the

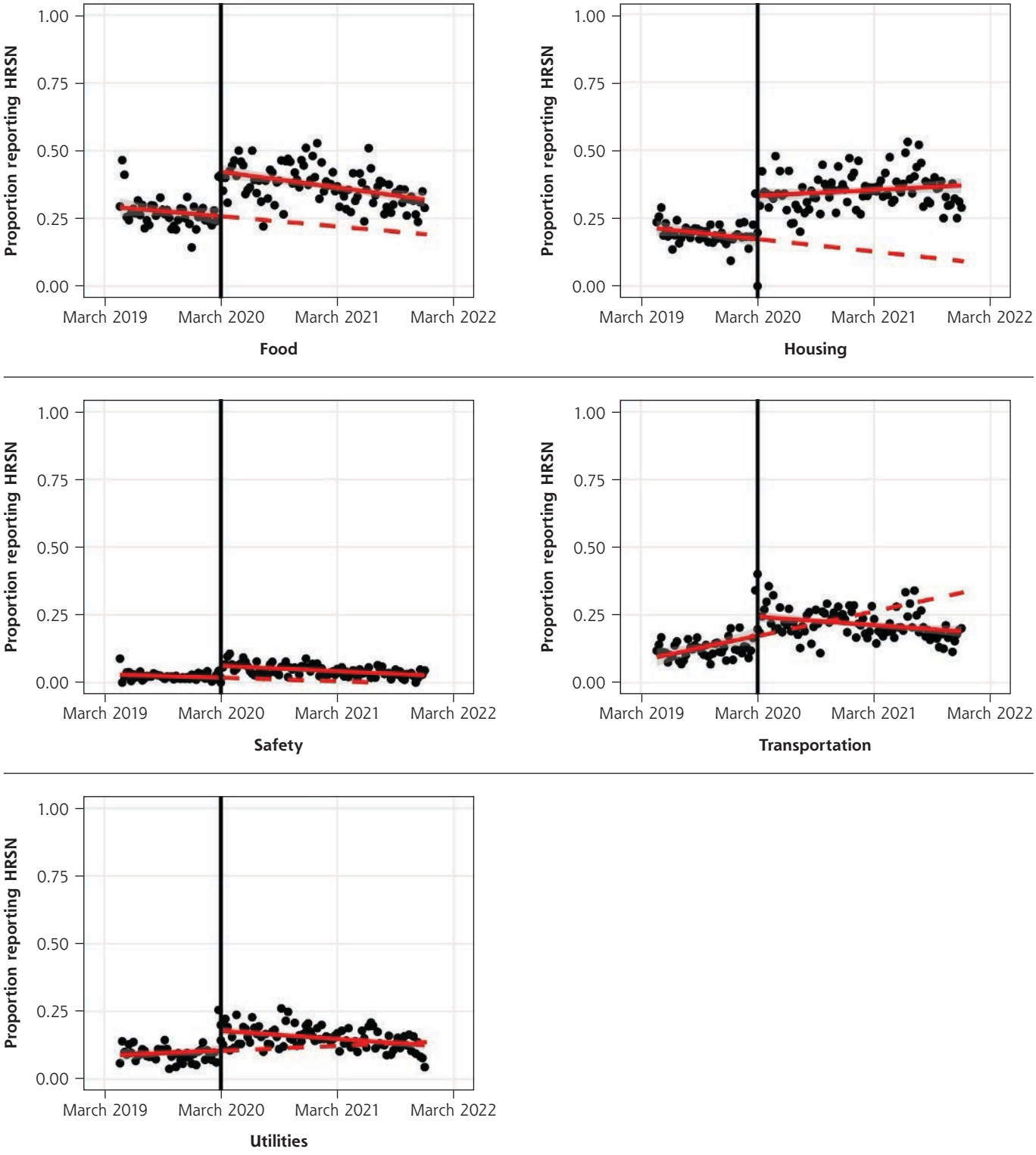
Figure 1. Change in the proportion of beneficiaries reporting HRSN, aggregated by week, before and after Oregon's stay-at-home order.



HRSN = health-related social needs.

Notes: HRSN were reported between May 13, 2019 and December 24, 2021. The black line at March 23, 2020 marks the Oregon governor's stay-at-home order (a proxy for the "intervention" of the COVID-19 pandemic in the model). The solid red lines indicate the lines of best fit before and after the order; the gray bands show the CIs for those lines. The broken red line is the counterfactual line (ie, expected trend if the pandemic had not happened).

Figure 2. Change in the proportion of beneficiaries reporting various types of HRSN, aggregated by week, before and after Oregon's stay-at-home order.



HRSN = health-related social needs.

Notes: HRSN were reported between May 13, 2019 and December 24, 2021. The black line at March 23, 2020 marks the Oregon governor's stay-at-home order (a proxy for the "intervention" of the COVID-19 pandemic in the model). The solid red lines indicate the lines of best fit before and after the order; the gray bands show the CIs for those lines. The broken red line is the counterfactual line (ie, expected trend if the pandemic had not happened).

data.[30] ITS is strengthened by the use of a control group[18,19]; however, as COVID-19 was pervasive, no comparable control group is available. These challenges are common among other research studies of the pandemic period.[31] Another limitation of the study may be selection bias introduced at the site level. Study staff noted lower than expected accruals at all sites, particularly with the onset of the pandemic. Sites cited pandemic priorities, staff turnover, and short clinical visits as barriers to universal screening. Additionally, our analysis was limited to Medicare and Medicaid beneficiaries in Oregon and may not be generalizable to populations who do not regularly access health care or have other insurance types. There are opportunities to explore whether findings are consistent among similar populations in other states.

CONCLUSIONS

The pandemic exacerbated existing HRSN for Medicare and Medicaid beneficiaries in Oregon. An ITS analysis of AHC data collected before and after the state's COVID-19 stay-at-home order demonstrates an 17.7–percentage point increase in HRSN among this population that persisted long after the start of the pandemic. This increase is particularly concerning for Medicaid beneficiaries, who are more likely to belong to a racially or ethnically minoritized group compared with the broader US population.[32] The high prevalence and persistence of HRSN is a societal concern. Additional public investments in social service delivery systems, and population-specific actions by payers and clinical systems may be effective strategies to begin addressing this intractable need.

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Key words: health-related social needs; COVID-19 pandemic; Medicare; Medicaid; mass screening; housing instability; food insecurity; safety; social determinants of health; elderly; vulnerable populations

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Supplemental materials

References

1. Alderwick H, Gottlieb LM. Meanings and misunderstandings: a social determinants of health lexicon for health care systems. *Milbank Q*. 2019;97(2):407-419. 10.1111/1468-0009.12390
2. Thornton RL, Glover CM, Cené CW, Glik DC, Henderson JA, Williams DR. Evaluating strategies for reducing health disparities by addressing the social determinants of health. *Health Aff (Millwood)*. 2016;35(8):1416-1423. 10.1377/hlthaff.2015.1357
3. Fallah-Aliabadi S, Fatemi F, Heydari A, et al. Social vulnerability indicators in pandemics focusing on COVID-19: a systematic literature review. *Public Health Nurs*. 2022;39(5):1142-1155. 10.1111/phn.13075
4. Thomas DSK, Jang S, Scandlyn J. The CHASMS conceptual model of cascading disasters and social vulnerability: The COVID-19 case example. *Int J Disaster Risk Reduct*. 2020;51:101828. 10.1016/j.ijdrr.2020.101828
5. Sharma SV, Chuang RJ, Rushing M, et al. Social determinants of health-related needs during COVID-19 among low-income households with children. *Prev Chronic Dis*. 2020;17:E119. 10.5888/pcd17.200322
6. Alizadeh H, Sharifi A, Damanbagh S, Nazarnia H, Nazarnia M. Impacts of the COVID-19 pandemic on the social sphere and lessons for crisis management: a literature review. *Nat Hazards (Dordr)*. 2023:1-26. 10.1007/s11069-023-05959-2
7. Kreuter MW, Garg R, Javed I, Golla B, Wolff J, Charles C. 3.5 Million social needs requests during COVID-19: what can we learn from 2-1-1? *Health Affairs Forefront*. Aug 4, 2020. 10.1377/forefront.20200729.432088
8. Miralles O, Sanchez-Rodriguez D, Marco E, et al. Correction to: Unmet needs, health policies, and actions during the COVID-19 pandemic: a report from six European countries. *Eur Geriatr Med*. 2021;12(3):667. 10.1007/s41999-021-00476-6
9. Miralles O, Sanchez-Rodriguez D, Marco E, et al. Unmet needs, health policies, and actions during the COVID-19 pandemic: a report from six European countries. *Eur Geriatr Med*. 2021;12(1):193-204. 10.1007/s41999-020-00415-x
10. Billioux A, Verlander K, Anthony S, Alley D. Standardized screening for health-related social needs in clinic settings: the Accountable Health Communities screening tool. *NAM Perspectives*. 2017. 10.31478/201705b
11. RTI International. *Accountable Health Communities (AHC) Model Evaluation: Second Evaluation Report*. Centers for Medicare & Medicaid Services; 2023.
12. State of Oregon. Office of the Governor. Executive Order 20-12: Stay Home, Save Lives: Ordering Oregonians to Stay at Home, Closing Specified Retail Businesses, Requiring Social Distancing Measures for Other Public and Private Facilities, and Imposing Requirements for Outdoor Areas and Licensed Childcare Facilities. Published Mar 23, 2020. https://www.oregon.gov/gov/eo/eo_20-12.pdf
13. Taljaard M, McKenzie JE, Ramsay CR, Grimshaw JM. The use of segmented regression in analysing interrupted time series studies: an example in pre-hospital ambulance care. *Implement Sci*. 2014;9:77. 10.1186/1748-5908-9-77
14. Hudson J, Fielding S, Ramsay CR. Methodology and reporting characteristics of studies using interrupted time series design in healthcare. *BMC Med Res Methodol*. 2019;19(1):137. 10.1186/s12874-019-0777-x
15. Jandoc R, Burden AM, Mamdani M, Lévesque LE, Cadarette SM. Interrupted time series analysis in drug utilization research is increasing: systematic review and recommendations. *J Clin Epidemiol*. 2015;68(8):950-956. 10.1016/j.jclinepi.2014.12.018
16. Penfold RB, Zhang F. Use of interrupted time series analysis in evaluating health care quality improvements. *Acad Pediatr*. 2013;13(6)(Suppl):S38-S44. 10.1016/j.acap.2013.08.002
17. Lopez Bernal J, Cummins S, Gasparrini A. The use of controls in interrupted time series studies of public health interventions. *Int J Epidemiol*. 2018;47(6):2082-2093. 10.1093/ije/dyy135
18. Bernal JL, Cummins S, Gasparrini A. Corrigendum to: Interrupted time series regression for the evaluation of public health interventions: a tutorial. *Int J Epidemiol*. 2020;49(4):1414. 10.1093/ije/dyaa118
19. Bernal JL, Cummins S, Gasparrini A. Interrupted time series regression for the evaluation of public health interventions: a tutorial. *Int J Epidemiol*. 2017;46(1):348-355. 10.1093/ije/dyw098
20. Ewusie JE, Blondal E, Soobiah C, et al. Methods, applications, interpretations and challenges of interrupted time series (ITS) data: protocol for a scoping review. *BMJ Open*. 2017;7(6):e016018. 10.1136/bmjopen-2017-016018
21. Chang HY, Tang W, Hatef E, Kitchen C, Weiner JP, Kharrazi H. Differential impact of mitigation policies and socioeconomic status on COVID-19 prevalence and social distancing in the United States. *BMC Public Health*. 2021;21(1):1140. 10.1186/s12889-021-11149-1
22. Haber NA, Clarke-Deelder E, Salomon JA, Feller A, Stuart EA. Impact evaluation of coronavirus disease 2019 policy: a guide to common design issues. *Am J Epidemiol*. 2021;190(11):2474-2486. 10.1093/aje/kwab185

23. Vokó Z, Pitter JG. The effect of social distance measures on COVID-19 epidemics in Europe: an interrupted time series analysis. *Geroscience*. 2020;42(4):1075-1082. 10.1007/s11357-020-00205-0

24. King A, Major-McDowall Z, Rothberg Z, Conway C, Tanrikulu L. Comparison of three methodologies for screening for social needs: in clinic, telephone, and text. *Ann Fam Med*. 2023;21(Suppl 1):3759. 10.1370/afm.21.s1.3759

25. Steeves-Reece AL, Davis MM, Hiebert Larson J, et al. Patients' willingness to accept social needs navigation after in-person versus remote screening. *J Am Board Fam Med*. 2023;36(2):229-239. 10.3122/jabfm.2022.220259R1

26. Steeves-Reece AL, Nicolaidis C, Richardson DM, et al. "It made me feel like things are starting to change in society:" a qualitative study to foster positive patient experiences during phone-based social needs interventions. *Int J Environ Res Public Health*. 2022;19(19):12668. 10.3390/ijerph191912668

27. Benfer EA, Koehler R, Mark A, et al. COVID-19 Housing Policy: State and federal eviction moratoria and supportive measures in the United States during the pandemic. *House Policy Debate*. 2023;33(6):1390-1414. 10.1080/10511482.2022.2076713

28. Oregon Health Authority. Social determinants of health (SDOH) incentive metric. Published Nov 17, 2023. Accessed Sep 28, 2024. https://www.oregon.gov/oha/hpa/dsi-tc/pages/sdoh-metric.aspx

29. Oregon Health Authority. Health-related services summary: 2021 CCO Health-Related Services Spending. Published Sep 2021. Accessed Sep 28, 2024. https://www.oregon.gov/oha/HPA/dsi-tc/Documents/2021-CCO-HRS-Spending-Summary.pdf

30. Moineddin R, Upshur RE, Crighton E, Mamdani M. Autoregression as a means of assessing the strength of seasonality in a time series. *Popul Health Metr*. 2003;1(1):10. 10.1186/1478-7954-1-10

31. Holtrop JS, Davis MM. Primary care research is hard to do during COVID-19: challenges and solutions. *Ann Fam Med*. 2022;20(6):568-572. 10.1370/afm.2889

32. Proctor K. CMS releases data briefs that provide key Medicaid demographic data for the first time. Published Jul 25, 2023. Accessed Sep 28, 2024. https://www.cms.gov/blog/cms-releases-data-briefs-provide-key-medicaid-demographic-data-first-time