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LEVERAGING THE SOCIAL DETERMINANTS OF HEALTH: WHAT WORKS?

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Abstract: This paper summarizes recently published, peer-reviewed literature about the impact on health outcomes and health care spending of investments in social services or investments in integrated health care and social services. Of 39 articles that met criteria for inclusion in the review, 32 (82%) reported some significant positive effects on either health outcomes (N=20), health care costs (N=5), or both (N=7). Of the remaining seven (18%) studies, three had nonsignificant results, two had mixed results, and two had negative results in which the interventions were associated with poorer health outcomes. Our analysis of the literature indicates that several interventions in the areas of housing, income support, nutrition support, and care coordination and community outreach have had positive impact in terms of health improvements or health care spending reductions. These interventions should be of interest to health care policymakers and practitioners. Nonetheless, additional studies identifying health care cost offsets attributable to social service investments are warranted.

Introduction

Social determinants of health have taken center stage in recent health policy discussions, particularly with the growing focus on global payment, accountable care organizations (ACOs), and other initiatives focused on improving population health. Health care providers are being asked to measure outcomes that have, traditionally, been outside their sphere of influence: health outcomes of the population, in addition to their costs and the quality of health care they deliver. Given that medical care influences a relatively small portion of overall health (Marmot, 2005; McGinnis, Williams-Russo, & Knickman, 2002), ACO and value-based financing models face substantial challenges in equipping health care providers to achieve improvements in the population's health.

Many researchers have examined the relative contributions of health care services, genetics, behaviors, environment, and social factors in promoting health and reducing premature mortality (Bradley & Taylor, 2013; Lee & Paxman, 1997; McGinnis et al., 2002; Prus, 2011). Overwhelmingly, studies find that nonmedical factors, including social, behavioral, and environmental determinants of health, consistently play a substantially larger role than medical factors. Similar patterns hold for specific health outcomes, including high-cost diseases such as heart disease, stroke, and diabetes (Hu et al., 2001; Platz et al., 2000; Stampfer et al., 2000), although the relative contributions may vary by 5 to 10 percent depending on the health outcome in question.

Despite the evidence, an enduring challenge for research into the social determinants of health has been translating its insights into actionable recommendations. The literature is replete with studies dating to the 1970s showing that social determinants of health connected with poverty are harmful to health both in the short and longer terms (Braveman et al., 2010; Freedman, Grafova, & Rogowski, 2011; Myers et al., 2014) as well as a growing body of literature that demonstrates the effects of positive social conditions on health outcomes (Carroll-Scott et al., 2013; Kumar et al., 2012; Loucks et al., 2015). Nevertheless, the literature has not been reviewed comprehensively to generate an integrated, evidence-based summary of how to best address the social determinants to achieve positive health effects without increasing (and perhaps even decreasing) health care spending. Accordingly, we sought to synthesize the existing empirical evidence about the impact of social service interventions on health outcomes and health care spending, with particular attention to identifying programs and practices that achieved both improvements in health as well as potential reductions in health care spending.

Methods

We summarized peer-reviewed literature that examined the impact on health outcomes and health care spending of investments in social services or investments in integrated models of health care and social services. We used the PubMed database to execute our initial search and

included relevant literature published in English between January 2004 and October 2014. We ran a number of search strings comprised of a combination of social and health keywords. We included the following social service keywords: "social service," "social spending," "social welfare," "housing," "education," "income support," "nutrition," "food stamp," "SNAP," "public safety," and "transportation." For health and health care we used the following keywords: "health," "health outcomes," "health saving," "health costs," "health spending," and "health expenditure." Eligibility criteria included a social service intervention or a health care intervention that specifically targeted a social, behavioral, or environmental determinant of health; quantitative measurement of a health outcome, health care costs, or both; and well-documented study design. We also reported utilization outcomes such as hospital admissions and emergency department visits, as these can involve changes in health care spending as well. We excluded papers that only examined health behaviors (e.g., cigarettes smoked, steps walked) rather than health outcomes.

The search yielded 123 unique articles; screening and analysis were conducted by three members of the research team (LT, CC, CN), who met frequently to review decisions and disagreements, which were resolved through negotiated consensus. A total of 80 of the 123 studies were excluded for not meeting eligibility criteria based on a review of their abstracts, leaving 43 articles for full article review. The review of the 43 full-length articles resulted in exclusion of an additional four articles, yielding a sample of 39 articles for analysis (Figure 1). These 39 articles were reviewed independently by the three members of the research team (LT, CC, CN) to record data on study design, sample characteristics, geographic location, description of the social service intervention, and empirical findings related to intervention-associated changes in health outcomes or health care spending.

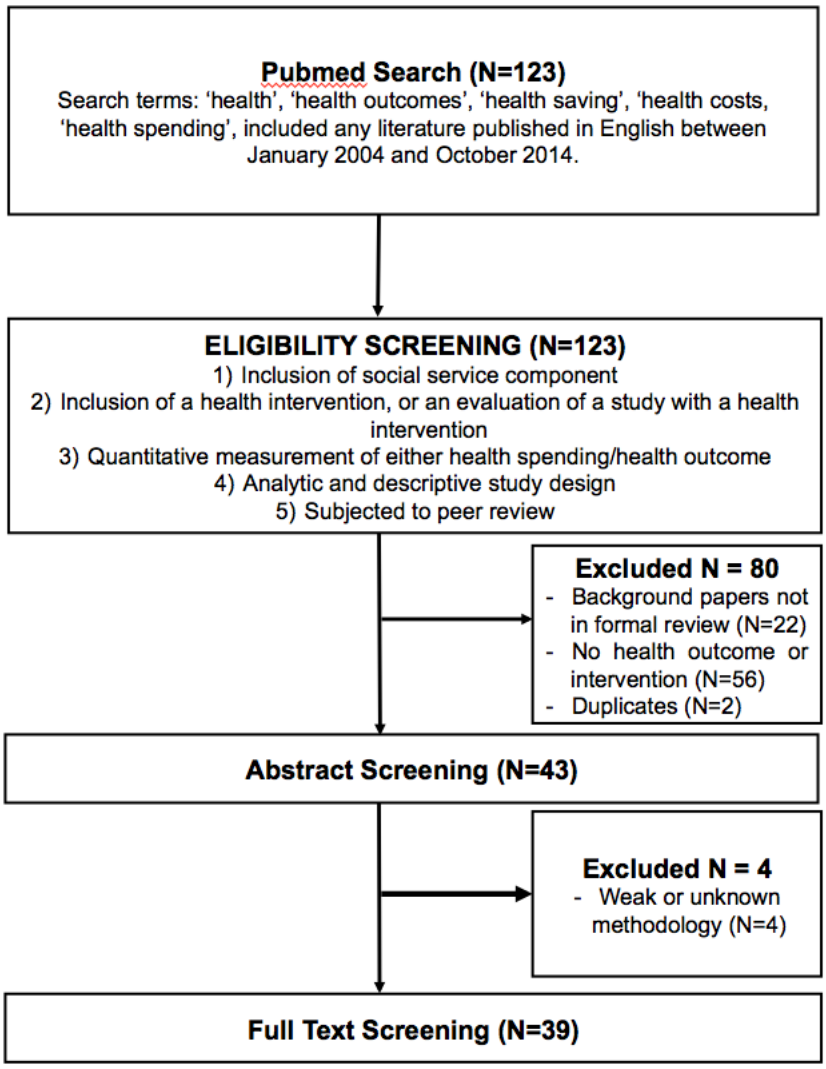
Results

Overview

Of the 39 articles, 32 (82%) reported some significant positive effects on either health outcomes (N=20), health care costs (N=5), or both (N=7). Of the remaining seven (18%) studies, three had nonsignificant results, two had mixed results, and two had negative results in which the interventions were associated with poorer health outcomes. Studies with nonsignificant, mixed, and negative findings did not reflect a particular study design, intervention, or population. For instance, one of the studies with negative findings was a randomized controlled trial evaluating a housing intervention on the mental health of male adolescents (Kessler et al., 2014) while the other was a cross-sectional study evaluating Supplemental Nutrition Assistance Program (SNAP) participation on the BMI of low-income adults (Leung, Willett, & Ding, 2012). Approximately 72 percent of all studies included in this review focused on low-income populations.

Among the 32 studies with positive outcomes, 10 (31%) were related to housing support, 8 to care coordination and case management programs, 7 (22%) to nutritional support, 4 (13%) to income support, and 3 (9%) to education (Table 1). Study designs included nonintervention cohort studies (N=15), randomized controlled trials (N=12), cross-sectional (N=4), pre-post interventions (N=6), quasi-experimental (N=1), and post-test only evaluation (N=1). We identified no studies explicitly examining the health effects of transportation or public safety interventions.

Figure 1: Sampling Schematic



TOTAL: 39

Housing Support

Overall, of 12 studies evaluating housing intervention, four studies—three from the United States (Castle & Resnick, 2014; Garland et al., 2013; Rantz et al., 2014) and one from the UK (Edwards et al., 2011)—reported both improved health outcomes and reduced health care costs. Five additional studies showed improvement in health outcomes including obesity and diabetes among women with children (Ludwig, 2011), asthma among adults (Barton et al., 2007), self-reported health status among adults (Jacobs et al., 2014), mobility among low-income older adults (Szanton et al., 2011), and HIV outcomes (Hawk and Davis, 2012). One study found that the provision of housing was significantly associated with lower health care spending among the chronically homeless with severe alcohol addiction (Larimer, 2009). We also found one study, with nonsignificant results, pertaining to the effect on health care costs of a housing intervention that included housing and case management for homeless adults with chronic illness (Basu, Kee et al., 2012). One study reported significantly negative results pertaining to health outcomes. This study reported poorer mental health outcomes among the adolescent boys in the intervention group who were offered supportive housing in a neighborhood other than their own (Kessler et al., 2014).

Nutritional Support

Of the 11 studies related to nutritional support interventions, seven studies reported significantly improved health outcomes. Six studies were based in the United States (El-Bastawissi, Peters, Sasseen, Bell, & Manolopoulos, 2007; Joyce, Racine, & Yunzal-Butler, 2008; Khanani, Elam, Hearn, Jones, & Maseru, 2010; Kim, 2007; Lazariu-Bauer, 2004; Rimmer, Wang, Pellegrini, Lullo, & Gerber, 2013) and one was conducted in Canada (Muhajarine, 2012). No studies reported decreased health care costs associated with nutritional support interventions. Two studies reported null findings: one showed no significant relationship between food stamp recipients and diabetes, Medicare spending, or hospital utilization rates (Nicholas, 2011), and one reported no significant association between food assistance via a federally funded nutritional assistance program and probability of overweight/obesity (Ver Ploeg, Mancino, Lin, & Wang, 2007). One study (Leung, Willett, & Ding, 2012) reported significantly increased obesity associated with food assistance, and one study (Foster, Jiang, & Gibson-Davis, 2010) reported mixed results, showing that participation in SNAP for Women, Infants, and Children (WIC) was associated with significantly higher birth weights, but this result was sensitive to model estimation parameters.

Income Support

We found four studies related to income support, all of which demonstrated a positive relationship between income support interventions and health outcomes, or both health outcomes and health care costs. Three studies reported Supplemental Security Income had a positive effect on health outcomes including infant mortality (Arno, Sohler, Viola, & Schechter, 2009),

disability rates among the elderly (Herd, 2008), and mental health among former beneficiaries (Hogan, Speiglman, & Norris, 2010). We found one study (Frank et al., 2006) that showed both improved health outcomes and decreased health care costs; the Low Income Home Energy Assistance Program (LIHEAP) was associated with decreased probability of overweight and obesity among children and lower hospital admission rates.

Case Management and Community Outreach

Of the nine studies we reviewed with case management and community outreach interventions, four showed decreased health care costs associated with the intervention (Bhaumik et al., 2013; Karnick et al., 2007; Sadowski, 2009; Woods et al., 2012). Two other case management interventions were shown to have a significantly positive impact on health outcomes, specifically on all-cause mortality in mothers (Olds et al., 2014) and on birth weight among African American mothers (Kothari, Zielinski, James, Charoth, & Sweezy Ldel, 2014). Two community outreach studies were associated with lower health care costs and better health outcomes (Song, Hill, Bennet, Vavasis, & Oriol, 2013; Thomas & Mor, 2013). In these cases, community outreach interventions included a mobile health clinic and home-delivered meals. We also found one study with mixed results, showing that case management interventions reduced health care costs, but did not significantly impact quality-of-life related health outcomes (Counsell, Callahan, Clark, Stump, & & Ricketts, 2007).

Other

We found three studies related to interventions with primary educational components that were associated with improved health outcomes, especially among children. Two of these studies were based on the MEND trial, a multicomponent trial comprised of educational and physical activities designed to combat obesity among children aged 7 to 13 years (Fagg et al., 2014; Sacher et al., 2010). The third study was related to the Carolina Abecedarian Project, a program that was originally designed to promote cognitive development among disadvantaged children, which was ultimately shown to lower risk factors for cardiovascular and metabolic diseases among participants (Campbell, 2014).

Discussion

Our analysis of the literature indicates that several interventions in the areas of housing, income support, nutritional support, and care coordination and community outreach have had positive impact. These interventions should be of interest to health care policymakers and practitioners. Importantly, 100 percent of the studies evaluating income support programs, 88 percent of the care coordination and community outreach interventions, 83 percent of the housing support programs, and 64 percent of the nutritional support programs evaluated had statistically significant, positive effects on health outcomes alone or both health outcomes and health care

spending. Furthermore, the direction and magnitude of the results were robust to different study designs. Among randomized control trials and quasi-experimental studies, 85 percent of interventions showed positive health impacts or reductions in health spending.

Findings from this work, the majority of which was conducted with low-income populations, suggest that keeping a population healthy may require unconventional partners, such as housing authorities, food banks, and schools. The inclusion of researchers to document impact with empirically sound methods may further sustain and ultimately help to scale interventions targeted at the social determinants of health. Moreover, while case managers and care coordinators have become a ubiquitous feature of many health care systems, the literature provides an impetus for potentially expanding the scope of services that case managers and care coordinators are asked to manage. Careful consideration of these issues may be particularly prudent among health systems that have transitioned to value-based financing or accountable care models, where health outcomes have been explicitly prioritized in performance metrics.

The literature highlights the "wrong pocket problem," a term coined by Dr. Erickson in 2014 with the California Department of Public Health, in which the savings that accompany health improvements do not accrue to the investor. In economic circles, this challenge is more commonly termed an externality. Many social service interventions (e.g., income support, housing) generate positive health outcomes, yet social service sectors receive little if any reward for their contribution. Similarly, depending on its payer and contract mix, a health care organization that contributes to a person's health does not reap the full social benefit from those health improvements. Thus, the wrong pocket problem discourages cross-sector collaboration when in fact the literature reviewed here suggests a high degree of mutual dependence and potential reward from coordinated health care and social services. These are questions we can and should be wrestling with more explicitly, particularly as literature like this empirically demonstrates the broad range of inputs required to create health.

Despite the substantial consistency of the findings overall, several limitations and gaps were apparent in the literature. First, the number of studies that examine impact on health care spending was relatively modest. As policymakers, payers, and providers seek to support programs that address the social determinants of health, understanding the health care cost offsets will be critical for widespread endorsement. Second, few studies examine interventions related to transportation services, public safety, education, and income support programs; and the majority of studies examine impacts on low-income groups, limiting the generalizability of findings. Third, several studies would be strengthened by better comparison groups, larger samples, and more sophisticated analytical methods to address potential confounding influences. These limitation of the literature, combined with larger cultural fallacies regarding the

equivalence of health and health care and the prioritization of the individual, continue to hamper the translation of these findings into policy (Goldberg, 2012).

In summary, we found substantial evidence of improved health outcomes and/or reduced health care spending related to interventions that addressed housing, nutrition, income support, and care coordination and community outreach needs. At the same time, this literature can be improved in scope and rigor. Further studies, particularly examining a broader set of interventions with methods to determine causal effects on both health outcomes and health care spending, are needed to produce a comprehensive understanding of the degree to which interventions to address the social determinants of health care improve health and reduce health care costs.

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Table 1: Summary of findings in the literature (N=39)

Findings	Housing Support N (%)	Nutrition Support N (%)	Income Support N (%)	Care Coordination and Outreach N (%)	Other N (%)	Total N (%)
Positive, significant findings						
Positive health outcomes	5 (42%)	7 (64%)	3 (75%)	2 (22%)	3 (100%)	20 (51%)
Reduced costs	1 (8%)	0 (0%)	0 (0%)	4 (44%)	0 (0%)	5 (13%)
Both health outcomes and reduced costs	4 (33%)	0 (0%)	1 (25%)	2 (22%)	0 (0%)	7 (18%)
Other findings						
Mixed results	0 (0%)	1 (9%)	0 (0%)	1 (9%)	0 (0%)	2 (5%)
Nonsignificant effects	1 (8%)	2 (18%)	0 (0%)	0 (0%)	0 (0%)	3 (8%)
Negative health outcomes	1 (8%)	1 (9%)	0 (0%)	0 (0%)	0 (0%)	2 (5%)
Total	12 (100%)	11 (100%)	4 (100%)	9 (100%)	3 (100%)	39 (100%)

Table 2: Summary of Studies

Category	Author, Title	Year	Association Between Programs' Services and Health Outcomes/Spending (+/-)	Study Location	Study Design, Sample Type and Total Number of Participants	Key Findings (Health Outcomes, Cost Savings)
Health Care and Social Service Partnerships						
Case management	**Basu, A., Kee, R., Buchanan, D., & Sadowski, L. S.,** *Comparative Cost Analysis of Housing and Case Management Program for Chronically Ill Homeless Adults Compared to Usual Care*	2011	Negative	Chicago, IL	**Intervention**: Housing and case management program **Study design**: RCT **Study sample**: 407 homeless adults with chronic medical illnesses	**Outcomes**: Cost savings. The intervention group generated a cost savings of $6,307 per person (p=0.23). Among those who were chronically homeless, there was an associated cost saving of $9,809 and among those living with HIV, $6,622.
	Bhaumik, U., Norris, K., Charron, G., Walker, S. P., Sommer, S. J., Chan, E., ... & Woods, *A Cost*	2013	Positive	Boston, MA	**Intervention:** Boston Children's Hospital Community Asthma Initiative (CAI) **Study design:** Retrospective cost-	**Outcomes**: Cost savings. The CAI was associated with an adjusted ROI of 1.33 during the first three years, after controlling for other factors other than the CAI

	Analysis for a Community-Based Case Management Intervention *Program for Pediatric Asthma*				benefit analysis **Study sample:** 102 patients enrolled in the CAI program in the calendar year 2006.	intervention. After adding benefits due to reduction of missed school and work days, the social ROI increased to 1.85.
	Counsell, S. R., Callahan, C. M., Clark, D. O., Tu, W., Buttar, A. B., Stump, T. E., & Ricketts, G. D., *Geriatric Care Management for Low-Income Seniors*	2008	Mixed		**Intervention:** Home-based care management for two years (Jan. 2002 to Aug. 2004) by a nurse practitioner and social worker who collaborated with the primary care physician and a geriatrics interdisciplinary team. **Study design**: Randomized controlled trial. **Sample type**: 951 adults aged 65 or older with an annual income of less than 200% of the federal poverty level.	**Outcomes**: Utilization of health care resources. The cumulative two-year emergency department (ED) visit rate per 1,000 was lower in the intervention group than the control (1,445 vs 1,748, p=0.03). Among the high risk of hospitalization patients, the ED (848 vs 1.314, p=0.03) and hospital admissions (396 vs 705, p=0.03) rates were lower among the intervention group compared to the control. However, hospital admissions rate did not differ significantly between the two groups (700 vs 740, p=0.66).
	Karnick, P., Margellos-Anast,	2007	Positive	Chicago, IL	**Intervention:** A combination of asthma	**Outcomes**: Utilization of

	H., Seals, G., Whitman, S., Aljadeff, G., & Johnson, D., *The Pediatric Asthma Intervention: A Comprehensive Cost-Effective Approach to Asthma Management in a Disadvantaged Inner-City Community*				education, reinforced education, and case management and reinforced education. **Study design:** Randomized controlled trial. **Sample type:** 212 children with asthma, aged 1 to 16 years**.**	health care resources. The average decline in utilization of health resources across all three intervention groups was significant: 69% for hospital days, 64% for ED visits, and 58% for clinic visits. Cost savings were greatest among the participants in the case management and reinforced education arm ($4,503/person) compared to asthma education ($4021/person) or reinforced education ($4140/person).
	Kothari, C. L., Zielinski, R., James, A., Charoth, R. M., & Carmen Sweezy, L. D, *Improved Birth Weight for Black Infants: Outcomes of a Healthy Start Program.*	2014	Mixed	Kalamazoo, MI	**Intervention:** Participation in the Healthy Babies Healthy Start program (HBHS), a case management approach to home visitation **Study design:** Secondary analysis (matched-comparison post-test only) of Michigan state- and Kalamazoo County-level birth certificate records for 2008–2010.	**Outcomes**: Birth outcomes. Black HBHS participants delivered higher birth-weight infants compared to Black nonparticipants (p=0.05). However, there was no significant difference in birth outcomes between White participants and nonparticipants (p=0.7 for birth weight; p=0.55 for gestation).

					Sample type: 9,336 women who were residents of Kalamazoo County when they gave birth during the years 2008–2010, of which 1,742 self-reported as Black and 7,174 self-reported as White.	
	Olds, D. L., Kitzman, H., Knudtson, M. D., Anson, E., Smith, J. A., & Cole, R. *Effect of Home Visiting by Nurses on Maternal and Child Mortality: Results of a Two-Decade Follow-up of a randomized clinical trial.*	2014	Positive	Memphis, TN	**Intervention:** Infant/toddler nurse home visiting beginning during pregnancy and continuing through child age two years. **Study design**: Randomized controlled trial. **Sample type**: 1,138 women who were primarily African American women at less than 29 weeks of gestation, no previous live births, and with at least two of the following socioeconomic characteristics: unmarried, have less than 12 years of education, and/or	**Outcomes**: All-cause mortality in mothers and preventable-cause mortality in children. The mean 21-year maternal all-cause mortality rate was significantly different (p=0.007) between control and treatment groups: 3.7% in the combined control groups (transportation/transportation + developmental screening) compared to 0.4% in the intervention group (transportation plus prenatal/postpartum home visiting for infants and toddlers).

					unemployed.	
	Sadowski, L. S., Kee, R. A., VanderWeele, T. J., & Buchanan, D., *Effect of a Housing and Case Management Program on Emergency Department Visits and Hospitalizations Among Chronically Ill Homeless Adults*	2009	Positive	Chicago, IL	**Intervention:** Housing offered as transitional housing after hospitalization discharge, followed by placement in long-term housing; case management offered at primary study sites, transitional housing, and stable housing sites. **Study design:** Randomized controlled trial **Sample type:** 407 social worker referred homeless adults with chronic medical illnesses from Sept. 2003 to May 2006.	**Outcomes:** Utilization of health care resources. After adjusting for baseline covariates, the intervention group had a relative reduction of 29% in hospitalizations (95% CI: 10-44%), 29% in hospital days (95% CI: 8-45%), and 24% in ED visits (95% CI: 3-40%).
	Woods, E. R., Bhaumik, U., Sommer, S. J., Ziniel, S. I., Kessler, A. J., Chan, E., ... & Nethersole, S., *Community Asthma Initiative:*	2012	Positive	Boston, MA	**Intervention**: Nurse case management and home visits with primary care and referral services, and nurse or nurse-supervised CHW home visits for asthma education,	**Outcomes:** Utilization of health care resources. At the 12-month mark of the study, there was a significant decrease in asthma ED visits (68.0%), any days of physical limitation (42.6%), patient (child) missed school (41.0%), and parent missed

	Evaluation of a Quality Improvement Program for Comprehensive Asthma Care				environmental assessment and remediation materials, and referral to IPM exterminator. **Study design:** Prospective cohort study **Sample type:** 283 children aged 2-18 living in four urban zip codes, with asthma, who had hospitalizations or ED visits from Oct. 1, 2005 – June 30, 2008	work (49.7%). There was a significant reduction in hospital costs compared with the comparison community ($p<0.0001$), with a return of investment of 1.46
Community outreach	**Sacher, P. M., Kolotourou, M., Chadwick, P. M., Cole, T. J., Lawson, M. S., Lucas, A., & Singhal, A.** *Randomized Controlled Trial of the MEND Program: A Family-Based Community Intervention for Childhood Obesity*	2010	Positive	United Kingdom	**Intervention**: Mind, Exercise, Do It (MEND) **Study design**: RCT **Sample type**: 116 obese children (BMI ≥ 98th percentile)	**Outcomes**: Health outcomes. Participants in the intervention had a reduced waist circumference (-0.37; $p<0.0001$) and BMI (-0.24; $p<0.0001$) at six months when compared to controls. The program had an 86% attendance rate, suggesting that the program could be feasibly implemented in the community.

	Song, Z., Hill, C., Bennet, J., Vavasis, A., & Oriol, N. E. *Mobile Clinic in Massachusetts Associated with Cost Savings from Lowering Blood Pressure and Emergency Department Use*	2013	Positive	Boston, MA	**Intervention:** The Family Van, a mobile clinic based in the Boston area **Study design:** Secondary analysis of a database with patient records from 1992–2009. **Sample type:** 5,900 patients' data were analyzed from Jan. 2010–June 2012	**Outcomes**: Health outcomes and cost savings. Patients who presented with high blood pressure in the first visit experienced mean reductions of 10.7 mmHg and 6.2 mmHg in systolic and diastolic blood pressure, respectively. These changes are associated with overall cost savings of $1.58 million in health care costs. The Family Van yielded a return on investment of 1.3.
	Thomas, K. S., & Mor, V., *The Relationship between Older* *Americans Act Title III State Expenditures and Prevalence of Low-Care Nursing Home Residents*	2013	Positive	United States	**Intervention:** Old Americans Act registered service expenditures for the years 2000–2009. **Study design:** Retrospective cohort design, 10 years of follow-up **Study sample**: 14,485 low-care residents in nursing homes (NHs).	**Outcomes**: Health outcomes and cost savings. Increased spending on home-delivered meals was associated with fewer residents in nursing homes with low-care needs. A decrease of 1% in number of low-care NH residents was associated with an additional $25 per person aged 65+ in the state.
Social Services						

Housing	**Kessler, R. C., Duncan, G. J., Gennetian, L. A., Katz, L. F., Kling, J. R., Sampson, N. A., ... & Ludwig, J**., Associations of Housing Mobility Interventions for Children in High-Poverty Neighborhoods With Subsequent Mental Disorders During Adolescence	2014	Negative	Boston, MA	**Intervention**: Housing mobility interventions: low-poverty voucher group, and a traditional voucher group. The low-poverty voucher group received vouchers to move to low-poverty neighborhoods with enhanced mobility counseling, whereas the traditional voucher group received geographically unrestricted vouchers. **Study design**: Randomized controlled trial from 1994–1998, with follow-up June 2008–April 2010. **Study sample**: 4,604 public housing families with 3,689 children in high-poverty neighborhoods. Children were aged 13–19 years at end of follow-up (0–8 years at randomization).	**Outcomes**: Mental health outcomes, including major depressive disorder, panic disorder, posttraumatic stress disorder (PTSD), oppositional-defiant disorder, intermittent explosive disorder, and conduct disorder. Boys in the low-poverty voucher group had significantly greater rates of depression compared to the control group (OR: 2.2, 95% CI: 1.2–3.9), as well as greater rates of conduct disorder (OR: 3.1, 95%: 1.7–5.8). However, girls in the traditional voucher group had decreased rates of major depression (OR: 0.6, 95%: 0.3–0.9) and conduct disorder (OR: 0.1, 95% CI: 0.0–0.4).
	Larimer, M. E., Malone, D. K.,	2009	Positive	Seattle, WA	**Intervention:** The Housing First	**Outcomes:** Cost savings.

	Garner, M. D., Atkins, D. C., Burlingham, B., Lonczak, H. S., ... & Marlatt, G. A., *Health Care and Public Service Use and Costs Before and After Provision of Housing for Chronically Homeless Persons with Severe Alcohol Problems*				intervention. **Study design**: Quasi-experimental design comparing housed and wait-listed participants enrolled between Nov. 2005 and March 2007. **Study sample**: 95 housed participants (drinking permitted) and 39 wait-list control participants.	Housing First participants incurred a median cost of $4,066 per person per month in the first year prior to the study. Median monthly costs decreased to $1,492 and $958 after 6 and 12 months in housing. There was a total cost rate reduction of 53% for housed participants relative to wait-list controls.
	Ludwig, J., Sanbonmatsu, L., Gennetian, L., Adam, E., Duncan, G. J., Katz, L. F., ... & McDade, T. W., *Neighborhoods, Obesity, and Diabetes—a Randomized Social Experiment.*	2011	Mixed	Baltimore, Boston, Chicago, Los Angeles, and New York City	**Intervention:** Housing vouchers that were redeemable only if participants moved to a low-poverty census tract, and unrestricted traditional vouchers. **Study design:** Randomized controlled trial **Study sample:** 4,498 women with children living in public housing in high-poverty urban census tracts, from	**Outcomes:** Health outcomes. The prevalence of BMI of 53 or more, BMI of 40 or more, and a glycated hemoglobin level of 6.5% or more were significantly *lower* in the group receiving the low-poverty vouchers than in the control group, with an absolute difference of 4.61 percentage points, 3.38 and 4.31 respectively.

					1994–1998.	
Nutrition	**El-Bastawissi, A. Y., Peters, R., Sasseen, K., Bell, T., & Manolopoulos, R.** *Effect of the Washington Special Supplemental Nutrition Program for Women, Infants And Children (WIC) on Pregnancy Outcomes.*	2007	Positive	Washington state	**Intervention**: Washington State Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). **Study design:** Retrospective-linkage cohort study **Study sample**: 42,495 women who enrolled in Washington WIC from 9/1/1999 to 12/31/2000.	**Outcomes**: Birth outcomes. WIC was protective for preterm delivery, being particularly protective for women with abortion and inadequate prenatal care (OR=0.4; 95% CI: 0.3–0.5). WIC was also shown to be protective against low birth weight depending on the women's cervical health, particularly among women with incompetent cervices (OR: 0.2; 95% CI: 0.1–0.6). WIC was also protective against fetal death, especially among women with less than 12 years of education (OR: 0.2, 95% CI: 0.1–0.3).
	Foster, E. M., Jiang, M., & Gibson-Davis, C. M. *The Effect of the WIC Program on the Health of Newborns*	2010	Mixed	United States	**Intervention:** Mother's participation in the WIC program **Study design:** Secondary analysis (using propensity scores to investigate the association between WIC participation and birth	**Outcomes**: Birth outcomes—birth weight, prematurity, maternal report of the infant's health, small for gestational age, placement in the neonatal intensive care unit. Among the unmatched samples, children born to

					outcomes) of the Child Development Supplement (CDS) of Panel Study of Income Dynamics **Study sample:** 3,181 children and their mothers with data collected from 1997–2002	WIC-recipients had lower score on the maternal health rating of the child, were more likely to be born low birth weight, small for gestational age. Using a fixed effects model, preterm birth was significantly lower among WIC participants (-0.07; p<0.05), birth weight (176.6 g; p<0.01) and low birth weight (-0.09; p<0.01).
	Joyce, T., Racine, A., & Yunzal-Butler*, C. *Reassessing the WIC Effect: Evidence from the Pregnancy Nutrition Surveillance System*	2008	Mixed	United States	**Intervention:** WIC participation **Study design:** Secondary analysis using data from nine states that participate in the Pregnancy Nutrition Surveillance System from 1995–2004. **Study sample**: N/A	**Outcomes:** Birth outcomes—birth weight (in grams), low birth weight, very low birth weight, preterm birth, small for gestational age. Prenatal WIC participation is associated with decreases in rates of low birth weight (2.7 percentage points), very low birth weight (0.9 percentage points), and preterm birth (2.8 percentage points). Women who delay

						enrollment in WIC until the third trimester have rates of preterm birth that are 6.1 percentage points lower than postpartum enrollees and 4.8 percentage points less than first-trimester enrollees. However, given the presence of gestational age bias, the gains are more modest.
	Khanani, I., Elam, J., Hearn, R., Jones, C., & Maseru, N., *The Impact of Prenatal WIC Participation on Infant Mortality and Racial Disparities*	2010	Positive	Hamilton County, OH	**Intervention:** WIC participation **Study design:** Retrospective cohort study using data from WIC prenatal participants in Hamilton County, Ohio. **Study sample:** 18,091 women enrolled in WIC in the prenatal period.	**Outcomes:** Birth outcomes—preterm births, infant mortality rates White WIC participants were less likely to have preterm births compared to non-WIC participants (10.3% vs 8.7%, p=0.004). African American WIC participants were less likely to have preterm births compared to non-WIC participants (13.7% vs 20.0%, p<0.001).
	Kim, K. & Frongillo, E.A. *Participation in Food Assistance Programs Modifies the*	2007	Positive	United States	**Intervention:** Participation in food assistance programs, i.e., food stamps and home-delivered meals. **Study design:**	**Outcomes:** Health outcomes—BMI and depression. **BMI**: For AHEAD, food insecurity was positively associated to

	Relation of Food Insecurity with Weight and Depression in Elders				Secondary analysis of the Health and Retirement Study (1996–2002) (HRS) and the Asset and Health Dynamics Among the Oldest Old dataset (1995–2002) (AHEAD). **Study sample:** 9,481 from HRS and 6,353 for AHEAD	BMI among nonparticipants in the Food Stamp program, but not related to BMI among participants ($p<0.004$). Current food-insecure elders had higher BMI than current food-secure elders by 0.19 unit of BMI ($p<0.033$). **Depression**: Current food-insecure elders had higher depression scores than food-secure elders in both HRS ($\beta=0.27$, $p<0.001$) and AHEAD $\beta=0.18$, $p<0.051$).
	Lazariu-Bauer, V., Stratton, H., Pruzek, R., & Woelfel, M. L., *A Comparative Analysis of Effects of Early Versus Late Prenatal WIC Participation on Birth Weight: NYS, 1995*	2004	Positive	New York State	**Intervention:** Participation in the WIC program. **Study design:** Secondary analysis of dataset from the New York State WIC program. **Study sample:** Mother-infant pairs comprising of infants born in New York State in 1995 whose mothers	**Outcomes**: Birth outcomes Infants born to WIC participants who enrolled early were 70 g heavier on average than those who enrolled late. Black and Hispanic full-term infants experienced larger WIC effects than Whites (79, 75, 43 g, respectively). Effects of longer prenatal WIC participation were greatest for the inadequate

					participated in the WIC program during their pregnancy. 77,601 records were available for analysis.	prenatal care group (83 g).
	Leung, C. W., Willett, W. C., & Ding, E. L., *Low-Income Supplemental Nutrition Assistance Program Participation Is Related to Adiposity and Metabolic Risk Factors*	2012	Negative	United States	**Intervention:** Participation in the Supplemental Nutrition Assistance Program (SNAP) **Study design:** Cross sectional analysis of NHANES data 2003–2006**.** **Study sample:** 2,250 low-income adults	**Outcomes:** Health outcomes **(BMI)** SNAP participation was positively associated with obesity (PR: 1.58), waist circumference in men (PR: 2.04), and waist circumference in women (PR: 2.95). *PR = prevalence ratio
	Muhajarine, N., Ng, J., Bowen, A., Cushon, J., & Johnson, S., *Understanding the Impact of the Canada Prenatal Nutrition Program: A Quantitative Evaluation.*	2012	Positive	Canada	**Intervention:** Canada Prenatal Nutrition Program (CPNP)**,** a population-level health intervention that aims to contribute to improve health outcomes for pregnant women and newborn children under high-risk conditions. **Study design:** Observational cohort	Participants with high CPNP exposure were less likely to have pre-term birth 0.74 (0.65–0.84), low birth rate 0.66 (0.60–0.72), small for gestational age 0.89 (0.83–0.96), and poor neonatal health 0.83 (0.78–0.88). They were more likely to have babies large for gestational age 1.22 (1.11–1.35) all $p<0.05$.

					study. **Study sample:** 250,000 women who entered the CPNP program between 2002–2006.	
	Nicholas, L. H., *Can Food Stamps Help to Reduce Medicare Spending on Diabetes?*	2011	Negative	United States	**Intervention**: Food Stamp receipt **Study design**: Secondary analysis using longitudinal data from the Health and Retirement Study (HRS) linked to Medicare claims data. **Study sample**: 30,887 older Americans who were interviewed at least once between 1992 and 2006.	**Outcomes:** Health care and utilization of health care resources. There was no significant relationship between Food Stamp recipients and Medicare spending for older diabetics. (p>0.05)* There was no significant difference between hospitalization for diabetes or in outpatient utilization status between recipients and non-recipients (p>0.05).* Exact p-value not reported.
	Rimmer, J. H., Wang, E., Pellegrini, C. A., Lullo, C., & Gerber, B. S., *Telehealth Weight Management Intervention for*	2013	Positive	United States	**Intervention:** Low-cost telephone intervention supported with a web-based remote coaching tool called POWERS. POWERS contains the following sections: health appraisal, goal	**Outcomes:** Health outcomes (body weight) There was a significant group and time interaction (P < 0.01) in post-intervention body weight. Both the POWERS and

	Adults with Physical Disabilities: A Randomized Control Trial.				setting, implementation strategies, notes, and links to health promotion materials. Another arm called POWERSplus comprised of coaching and provision of nutritional information. **Study design:** Randomized controlled trial **Study sample:** 102 people with physical disabilities (spinal cord injury, multiple sclerosis, spina bifida, cerebral palsy, stroke, or lupus).	POWERSplus groups demonstrated greater reduction in body weight compared with the control group (POWERS: -2.1 ± 5.5 kg, -2.4 ± -5.9%; POWERSplus: -0.5 ± 5.0 kg, -0.6 ± 4.3%; control: +2.6 ± 5.3 kg, 3.1 ± 7.4%).
	Ver Ploeg, M., Mancino, L., Lin, B. H., & Wang, C. Y., *The Vanishing Weight Gap: Trends in Obesity Among Adult Food Stamp Participants (US)(1976–2002).*	2007	Negative	United States	**Intervention:** USDA's Food Stamp Program **Study design:** Secondary analysis from NHANES (1976–1980, 1988–1994, 1999–2002). **Study sample:** 20,845 observations	The association between food assistance program participation and body weight measures has decreased over the past 30 years. Specifically among white women, the results showed that there was no significant difference in BMI or probability of overweight/obesity between food stamp participants and

						eligible nonparticipants.
Income Support	**Arno, P. S., Sohler, N., Viola, D., & Schechter, C.** *Bringing Health and Social Policy Together: The Case of the Earned Income Tax Credit*	2009	Positive	United States	**Intervention**: Earned income tax credit program **Study design**: Secondary analysis using data from the Annual Social and Economic Supplement to the 2001 Current Population Survey (CPS). **Study sample**: Children in households headed by an unmarried woman, or a married woman with absent spouse, with low/moderate incomes (<$30,000).	**Outcomes**: Health outcomes (infant mortality) and insurance coverage. Each percentage point increase in EITC penetration (within or between states) is associated with a 23.2 per 100,000 *reduction* in infant mortality rate (P = 0.013). Among mothers who were not eligible for the credit, 75% reported all of their children lacked health insurance coverage. However, among mothers who were eligible for the EITC, 54% reported all of their children lacked health insurance coverage (P< 0.00005). Single mothers with low or moderate incomes who were ineligible for the EITC program were 1.4 times more likely to lack health insurance for all of their children than single mothers who were eligible to receive the credit.
	Frank, D. A., Neault, N. B., Skalicky, A.,	2006	Positive	Baltimore, MD; Boston, MA; Little	**Intervention:** Low Income Home Energy Assistance Program	**Outcomes:** Health outcomes and health care resource utilization.

	Cook, J. T., Wilson, J. D., Levenson, S., ... & Berkowitz, C. *Heat or Eat: The Low Income Home Energy Home Assistance Program and Nutritional and Health Risks among Children Less than 3 Years of Age*			Rock, AK; Los Angeles, CA; Minneapolis, MN; Washington, DC	(LIHEAP) **Study design:** Cross-sectional. **Study sample:** 7,074 caregivers with children < 3 years of age with household assistance and food insecurity from Jun 1998–December 2004.	(Height/weight as proxy for undernutrition, and recent emergency department admissions.) Children aged 2–3 years in recipient households were not more likely to be overweight (BMI ≥95th percentile) than those in nonrecipient households (AOR: 0.83; 95% CI: 0.46–1.49). Rates of age-adjusted lifetime hospitalization—excluding birth and the day of the interview—did not differ between recipient groups. Among the 4,445 of 7,074 children evaluated in the two EDs, children from households not receiving the LIHEAP had greater odds of acute hospital admission than those in recipient households (OR: 1.32 (1.00-1.75; p<.05).
	Herd, P., Schoeni, R. F., & House, J. S. *Upstream*	2008	Positive	United States	**Intervention:** Supplemental Security Income (SSI) **Study design:**	**Outcomes:** Health outcomes (disability) Higher benefits are linked to lower disability rates. A $100

	Solutions: Does the Supplemental Security Income Program Reduce Disability In the Elderly?				Secondary analysis using data from the 1990 and 2000 censuses, employing fixed effects models, to test whether within-state changes in maximum SSI benefits over time leads to changes in disability. **Study sample:** People aged 65 and older.	increase per month in the benefit was linked to a mobility limitation decrease of 0.46%. An increase of $100 in the maximum monthly state SSI benefit leads to a 1.8 percentage point decline in the probability of having a mobility limitation among low-income individuals.
	Rosen, M. I., McMahon, T. J., Lin, H., & Rosenheck, R. A., *Effect of Social Security Payments on Substance Abuse in a Homeless Mentally Ill Cohort.*	2006	Positive	United States	**Intervention:** SSI/SSDI benefit **Study design:** 12-month cohort study completed over four years. **Study sample:** 6,199 SSI and SSDI eligible adults.	**Outcomes:** Health outcomes (drug and alcohol use) Newly awarded SSA beneficiaries did not differ in drug use over time, but were housed for an average of 13 more days per year, and were employed 12 fewer days. However, all participants—including those who never received SSA—reduced their drug use significantly on seven out of eight outcomes ($p<0.005$). Results showed that SSA does not perpetuate drug use.
Education	**Campbell, F.,**	2014	Positive	Chapel Hill,	**Intervention**: Carolina	**Outcomes**: Health

	Conti, G., Heckman, J. J., Moon, S. H., Pinto, R., Pungello, E., & Pan, Y. *Early Childhood Investments Substantially Boost Adult Health*			NC	Abecedarian Project, an early childhood development program aimed at preventing development of mild mental retardation among disadvantaged children (ABC) **Study design**: Cohort study with long follow-up evaluated by randomization **Study sample**: 111 children born between 1972 and 1977 who were living or in Chapel Hill, NC	outcomes (risk factors for cardiovascular disease, metabolic disease). Disadvantaged children randomly assigned to treatment have significantly lower risk factors for cardiovascular and metabolic diseases in their mid-30s, particularly among males. On average, systolic blood pressures between control and treatment group were significantly different (143 mmHg vs 126 mmHg, p=0.018). One in four males had metabolic syndrome in the control group, compared to none in the treatment group (p=0.007).
	Fagg, J., Chadwick, P., Cole, T. J., Cummins, S., Goldstein, H., Lewis, H., ... & Law, C., *From Trial to Population: A Study of a Family Based Community*	2014	Positive	United Kingdom	**Intervention**: Family-based weight intervention called MEND 7-13 (Mind, Exercise, Nutrition, Do it!) **Study design**: Pre/post intervention evaluation. **Study sample**: 9,563 children who are	**Outcomes**: Health outcomes (BMI and psychological distress) After adjustment, in the intervention group, BMI reduced by 0.76 kg/m^2 on average (p<0.0001), self-esteem score increased by 3.53U (p<0.0001), and psychological distress

	Intervention for Childhood Overweight Implemented at Scale				overweight, and their family members	decreased by 2.64U ($p<0.0001$). These outcomes were less pronounced among children from less advantaged backgrounds and among Asians compared to white children.

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