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Identifying Relative Changes in Social Risk Factors An Analytic Approach

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Abstract

Background: Individuals often report concurrent social risk factors such as food insecurity, unstable housing, and transportation barriers. Comparing relative changes between pairs of social risk factors may identify those that are more resistant to change.

Objective: The objective of this study was to develop a method to describe relative changes in pairs of social risk factors.

Research Design: This was a prospective cohort study.

Subjects: Participants in a randomized controlled trial of hypertension care in an Urban Indian Health Organization.

Measures: We measured 7 social risk factors (housing, transportation, food, clothing, health care, utilities, and debts) at enrollment, 6, and 12 months among 295 participants in the trial. We hypothesized that pairwise comparisons could identify social risk factors that were less likely to change over time. We used conditional odds ratios (ORs) with 95% confidence intervals (CIs) to rank each pair.

Results: Food, clothing, health care, utilities, and debts had more changes between 0 and 6 months relative to housing (OR=2.3, 3.4, 4.7, 3.5, and 3.4, respectively; all 95% CI excluded 1.0). These same social risk factors also had more changes between baseline and 6 months relative to transportation (OR=2.8, 3.4, 4.9, 4.7, and 4.1, respectively; all 95% CI excluded 1.0). Changes in housing and transportation risk factors were comparable (OR=0.7, 95% CI: 0.4–1.4). Relative changes between 6 and 12 months were similar.

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Conclusions: Housing and transportation exhibited fewer relative changes than other social risk factors and might be more resistant to change. Awareness of the relationships between social risk factors can help define priorities for intervention.

Basic social resources such as food, housing, and transportation are critical determinants of health and health care outcomes.[1,2] Interventions to address the lack of these social risk factors may reduce health inequities, improve quality of care, and control health care costs.[3,4] Although most current research focuses on the identification and mitigation of individual social risk factors, many individuals experience multiple, concurrent social risk factors that change over time.[5–8] Such temporal changes in social risk factors are not well understood. While these changes may occur independently, there may be important relationships between them. For example, obtaining stable housing may facilitate food preparation and storage but may also oblige an individual to begin paying utility bills.[9,10]

For population planning in a health care system or community, systematic assessment of the changes in social risk factors in a cohort of individuals can identify common patterns of association between them. In particular, comparing pairs of social risk factors may identify which of the 2 is less likely to change over time. If the ability to pay for debts typically changes more frequently than housing status, program planners could conclude that, in general, housing is more resistant to change. This knowledge could then help prioritize interventions for individuals with multiple social risk factors.

During a randomized trial to improve hypertension care in an Urban Indian Health Organization (UIHO), we assessed 7 self-reported social risk factors among adult study participants on enrollment and at 6- and 12-month follow-up visits. This paper describes the patterns of change in these risk factors and the analytic methodology we developed to assess the relative changes between social risk factor pairs over time. On the basis of prior studies which demonstrated that interventions to provide housing have a substantial impact on other social risk factors,[9,10] we hypothesized that housing would have fewer relative changes than other social risk factors.

METHODS

Study Setting and Population

We conducted a randomized, controlled trial that enrolled patients who received primary care for hypertension at the First Nations Community Healthsource (FNCH), an UIHO in Albuquerque, NM.[11] FNCH is the largest program in a national network of 33 UIHOs.[12] Although only 1% of the federal Indian Health Service budget is allocated to UIHOs,[13] these organizations provide essential services for the >70% of American Indian/Alaska Natives (AI/AN) in the United States who reside in urban areas.[14] Like some other UIHOs, FNCH is designated as a federally qualified health center and a certified, patient-centered medical home. In addition to AI/AN, who comprise 40% of its clientele, FNCH serves members from a range of other racial and ethnic groups, including many recent immigrants to the US. In addition to primary care, FNCH offers a wide array of social services, including outreach to homeless individuals, assisted enrollment in federal and state food and health insurance

programs, and social work services to assist patients in addressing the social risk factors which they identify as individual needs.

The study protocol for the randomized trial, characteristics of the participants, and its main results have been published.[15,16] In brief, the trial enrolled 295 participants (19% of all patients identified in an FNCH hypertension registry). Individuals who were homeless at the time of recruitment were excluded because they could not receive the full study intervention. Individuals who had previously received support services for homelessness from FNCH were included, however. Those randomized to the intervention group received text messages or telephone reminders for primary care appointments; messages after missed appointments to encourage rescheduling; monthly reminders to refill medications; and weekly motivational messages about general health, management of hypertension, and cardiovascular risk.[15] These motivational messages did not address social risk factors such as housing or transportation. The study was approved by the institutional review board of Kaiser Permanente Colorado and by the Colorado Multiple Institution Review Board, and all participants provided written informed consent.

Participants were enrolled in the study during a baseline visit and were seen in person by study coordinators 6 and 12 months later. At each time point, participants completed surveys on a tablet computer; the full content of the survey has been published.[15] Among those who enrolled, 258 (88.1%) completed the 6-month follow-up visit and 247 (84.7%) completed the 12-month visit.[16]

Assessment of Social Risk Factors

Throughout this paper, we use the term “social risk factors” rather than the broader term “social determinants of health.”[17] To assess social risk factors at each study visit, we used the stem question, “How often do you *not* have …,” to assess whether participants had a decent place to live, enough food to eat, enough clothing, enough health care, enough money to pay for utility bills, adequate childcare, and enough money to pay for debts and credit card bills. Response options were: always/often/sometimes/almost never/never/does not apply. These questions were derived from a psychiatric epidemiology study conducted in 2 of the 3 largest AI/AN reservation communities in the United States in the 1990s.[18] In that study, community-based focus groups developed the social risk screening measures based on a qualitative review of questions included in earlier surveys. Since transportation was not included in the original survey, we adopted the transportation measure from the PRAPARE social needs assessment to ask whether lack of transportation had kept participants from medical appointments, meetings, work, or from getting things they needed for daily living.[19] This question had 3 response options: yes, it has kept me from medical appointments or from getting my medications/yes, it has kept me from nonmedical meetings, appointments, work, or from getting things that I needed/no. Information on social risk factors was collected for research purposes and was not provided to FNCH for clinical use.

Analytical Approach

We combined participants in the usual care and intervention groups of the randomized controlled trial into a single prospective cohort for the current analysis. The baseline

characteristics of the entire cohort have been published.[15] We then restricted the sample to participants who completed the baseline survey and the 6-month survey, the 12-month survey, or both, since at least 2 time points were necessary to assess possible changes in risk factors. We defined a social risk factor as present at each time point if the participant provided a response other than "never" or "not applicable." We identified a transportation risk factor if the participant reported a problem with either medical or nonmedical transportation. Childcare concerns were rarely reported by these middle-aged and elderly study participants and were not analyzed further. When a response was missing for a specific social risk factor, that risk factor was recoded as absent before further analysis.

Defining Changes in Social Risk Factors

For the 7 remaining social risk factors (housing, transportation, food, clothing, health care, utilities, and debts), we assessed the possible relationships between changes in social risk factor pairs, recognizing that we could not distinguish between causal and noncausal associations. We first defined 4 properties of each pair: the risk factors being assessed (A and B); the time point (beginning or end of the time interval); the status of each risk factor at each time point (1 if a risk factor was present, 0 if a risk factor was absent); and the nature of change between time points (changed or unchanged). These 4 properties defined the 16 relationships shown in Figure 1. We then collapsed these 16 relationships into 4 categories: (1) no change in either social risk factor between time points (4 relationships); (2) identical direction of changes in social risk factors between time points (2 relationships); (3) opposing direction of changes in social risk factors between time points (2 relationships); and (4) relative changes in social risk factors between time points (8 relationships). As an example of Category 2, resolving a housing risk factor (1→0) might be associated with increased capacity for food preparation and alleviate a food risk factor (1→0). As an example of Category 3, resolving a housing risk factor (1→0) might oblige the person to begin paying for utilities, creating a new risk factor (0→1).

Examples of relative changes (Category 4) would be changes in housing that are unassociated with a change in ability to pay debts, or conversely, changes in debt status that are unassociated with changes in housing. As shown in Figure 1, Category 4 thus includes instances when risk factor A changed between time points, while B did not, and other instances when risk factor B changed between time points, while A did not. A ratio of these relative changes that was significantly >1.0, designated as OR_{AB} in Figure 1, indicated that changes in A were less often associated with changes in B than changes in B were associated with changes in A. We could then conclude that A was more resistant to change than B.

We calculated the conditional odds ratio (OR) (used for the analysis of matched case-control studies in epidemiological research) to express the magnitude of the difference in relative changes between each risk factor pair, constructed its 95% confidence interval (CI), and compared the statistical significance of the differences using McNemar test for paired data.[20] To assess the relative resistance to change among all 7 social risk factors, we repeated this analysis for all 21 pairwise comparisons (comparing A–B, A–C, B–C, etc.). We used the Bonferroni correction method to adjust for multiple comparisons. Since 2

potential relative changes in risk factor status occurred during the trial (baseline to 6 mo and 6–12 mo), we confirmed our findings through independent analyses between baseline and 6 months and between 6 and 12 months. All analyses were conducted using SAS, version 9.4 (Cary, NC).[21] An annotated SAS program is provided in Appendix A (Supplemental Digital Content 1, https://links.lww.com/MLR/C128).

Consideration of Alternative Approaches

We developed this method after considering alternative methods for establishing hierarchies among variables. We considered linear and nonlinear regressions,[22] cluster analyses, discriminant models used in neural network analyses,[23–25] marginal structural models used to estimate causal effects in observational studies and social network analysis used for establishing dynamic social relationships.[26,27] However, these approaches traditionally have focused on cross-sectional data or on the association between risk factors and specific outcomes, and have not been applied to longitudinal data.

RESULTS

Sociodemographic characteristics of the 269 participants (91.1% of those enrolled in the trial) who completed the baseline survey and at least 1 follow-up survey are shown in Table 1. The study cohort was racially and ethnically diverse. Self-reported median household income was $10,000–19,999 per year. Although individuals who were homeless at baseline were excluded from the study, 16% reported prior support services for homelessness. The prevalence of social risk factors at baseline ranged from 16.1% of participants who reported not having decent housing to 54.7% who reported not having enough money to pay for debts. Missing values at baseline ranged from 0% for food to 2.4% for debts.

The changes in each social risk factor between baseline and 6 months and between 6 and 12 months are shown in Figure 2. Between baseline and 6 months, the need for housing, transportation, and clothing were most often unchanged and absent (0→0) (79.6%, 71.9%, and 64.2%, respectively), while the inability to pay for utilities, debts and health care were most often unchanged and present (1→1) (35.4%, 30.8%, and 21.5%, respectively). Changes between baseline and 6 months (0→1 and 1→0) were most common for health care, utilities, and debts (32.3%, 29.7%, and 27.7%, respectively).

Analysis of the relative change in housing and clothing between baseline and 6 months provides an example of our approach. Among 260 participants who reported housing as a social risk factor at baseline and 6 months, 228 (87.7%) had no change in housing status (1→1 or 0→0), while 32 had changes in housing (1→0 or 0→1). Among 260 patients who reported insufficient clothing as a social risk factor at baseline and 6 months, 197 (75.7%) had no changes in clothing status (1→1 or 0→0) while 63 experienced changes (1→0 or 0→1). Among the 32 participants with changes in housing status, 13 reported no changes in clothing (1→1 or 0→0). Among 63 patients with changes in clothing, 44 reported no changes in housing. For Table 2, the conditional OR for this pair of risk factors was calculated as 44/13=3.4 (95% CI: 1.8–6.8), indicating that individuals who reported housing as a risk factor had significantly fewer changes relative to clothing over the next 6

months than those with insufficient clothing had changes relative to housing over the same time period. We thus concluded that housing was more resistant to change than clothing.

Results of all pairwise comparisons among the 7 social risk factors in both time periods are shown in Table 2. After adjustment for multiple comparisons, housing had fewer relative changes than food, clothing, health care, or debts in both time periods. Transportation also had fewer relative changes than food, clothing, health care, debts, and utilities in both time periods. The number of relative changes between housing and transportation was similar (OR=0.7, 95% CI: 0.4–1.4 at baseline). Table 2 also shows that the ORs for the relative changes between social risk factors between 6 and 12 months were generally consistent with findings between baseline and 6 months. No pairwise comparisons between the other 5 social risk factors were statistically significant in both time periods.

DISCUSSION

In this analysis of changes in 7 self-reported social risk factors among a cohort of patients with hypertension from a randomized trial in an UIHO, we used simple statistics to conclude that, in this setting, changes in housing and transportation risk factors were relatively less likely to change than food, clothing, health care, utilities or debts over the same time period. On the basis of these findings, we propose that this approach can be used to identify social risk factors that are particularly resistant to change.

Maslow's[28] hierarchy is a classic model for assessing the relationships among human needs. Maslow proposed that physiological concerns such as food, shelter, warmth, and clothing are the most fundamental human needs. Even though all 7 social risk factors assessed in our study were at this very basic level, we anticipated that the relationships between social risk factors would be complex and that some social risk factors would change less frequently than others. For example, obtaining housing may facilitate food preparation; people who become homeless may no longer likely to report problems paying for utilities; transportation may facilitate access to health care, and so on. We used systematically collected, self-reported data on multiple social risk factors and their changes over two 6-month periods to develop a method through which we could investigate these relationships.

Although confirmation of these findings is necessary, these results support prior research which suggests that housing is a fundamentally important social risk factor. For example, an analysis of the 2012 Consumer Expenditure Survey found that high housing costs often resulted in reductions in food and transportation expenditures,[9] while a randomized trial, the Family Options Study, found that long-term housing subsidies reduced subsequent household food insecurity.[10] Our findings demonstrate that, despite its importance, housing is less likely to change over a 6-month time period than other social risk factors.

Unexpectedly, we found that transportation was also more resistant to change than food, clothing, health care, utilities, or debts. Transportation concerns may be particularly important in cities such as Albuquerque, where population density (2984 residents/mile^2) is substantially less than in other urban areas such as New York City (27,752 residents/mile^2).[29] Transportation risk factors may also be particularly consequential for the urban-

dwelling AI/AN who constituted 25% of study participants since they often travel between their home reservations in rural areas and nearby cities.[30]

The study has several strengths. We used standardized and culturally tailored methods to collect information about social risk factors at 3 consistent time points. Because data collection took place during a randomized trial, follow-up was high, and missing data were rare. Although the statistical methods were straightforward, their application to this research problem was novel. Because we were able to assess the temporal sequence of changes in social risk factors and the relationships among them at an individual level, these findings provide stronger evidence of meaningful associations than cross-sectional surveys.

Our findings have limitations. First, their generalizability may be limited, since individuals who completed the surveys all had hypertension and participated in a randomized, controlled trial. Although all participants were members of socioeconomically disadvantaged groups served by a UIHO/federally qualified health center, unmeasured characteristics may have differed between these individuals and the clinic population as a whole. We did not assess whether self-reported changes in social risk factors may have resulted from interventions initiated by clinic staff.

The single-item measures of social risk factors used in this study were primarily derived from previous research in AI/AN populations,[18] but, except for the transportation measure,[19] these items are not widely used. The time frame for these social risk factors was unstated. Information about test-retest reliability was not available in the literature and was not assessed in our study. Some questions elicited subjective judgments about the quality of resources rather than access to those resources. For example, the housing question asked about the self-perceived need for “decent” housing. Since risk factors were measured at 6-month intervals, changes that occurred between these time points could not be assessed. Similarly, it was not possible to determine whether changes in risk factors occurred simultaneously or sequentially within each time interval. The analytic method demonstrated here should be useful in assessing changes in social risk factors measured by other means, however.

The analytical approach also has limitations. The effective sample size was small because our analytic method only used information from individuals with relative changes in social risk factors. As a result, we may have failed to identify some associations, and confirmation of these findings with larger samples is necessary. While the method proposed here oversimplifies the complex interactions between multiple social risk factors, it does represent a first step toward understanding the relationships between social risk factor pairs, which have infrequently been addressed in prior research. More complex methods will be necessary to analyze longitudinal changes of multiple social risk factors in clinical practice, where missing data are common and measurement intervals vary.

Despite these limitations, we believe that this analytic approach provided a preliminary assessment of the relationships between pairs of social risk factors. The findings reinforce the importance of housing as a social risk factor that may be particularly resistant to change and suggest that more research into the relationships between transportation and other social

risk factors is warranted. As longitudinal observational studies and interventions to address social risk factors become more common, and as information about social risk factors is increasingly collected in clinical practice,[3] larger datasets should become available to assist health policymakers, social and medical care providers identify particularly recalcitrant social risk factors and develop interventions to address them.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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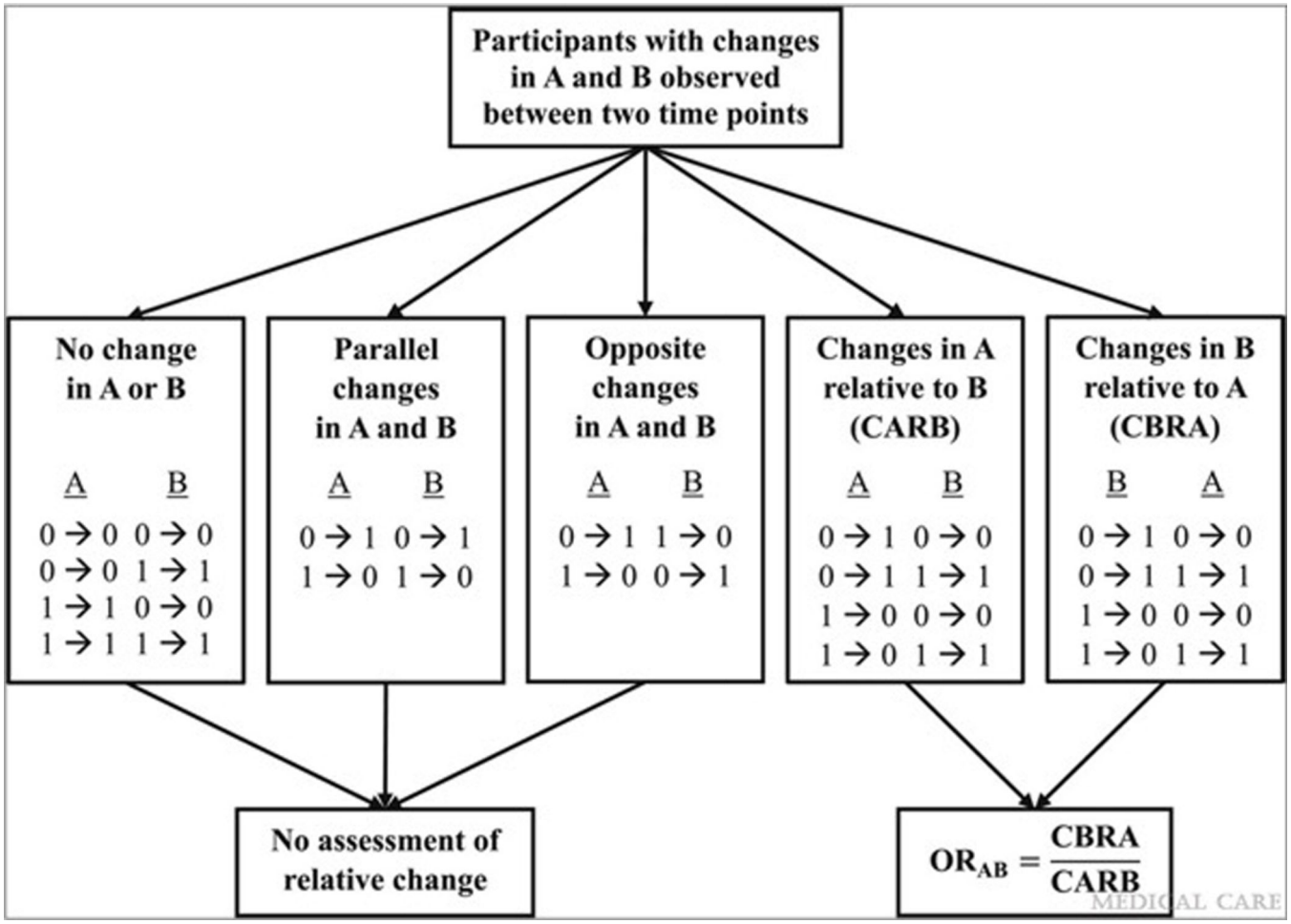

FIGURE 1:

Possible changes and calculation of relative changes between 2 social risk factors. The 2 social risk factors are denoted as Risk Factor A and Risk Factor B. Absence of a need is denoted as 0, the presence of a need is denoted as 1. Transitions between first and second time points are denoted as 0→0, etc. OR indicates odds ratio.

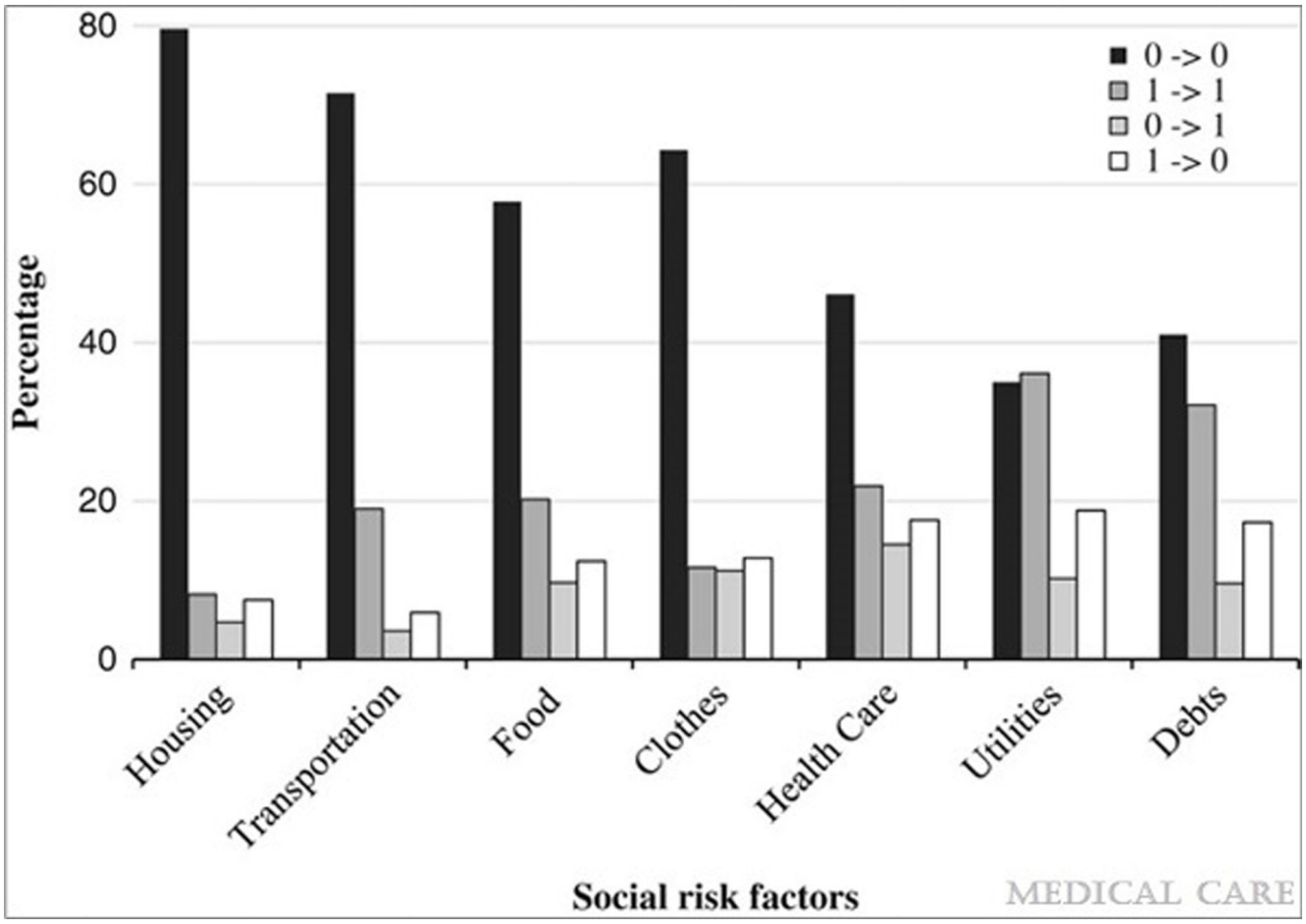

FIGURE 2:

Relative changes in 7 social risk factors between baseline and 6 months. Changes between 6 and 12 months are not shown but were similar. The absence of a need is denoted as 0, the presence of a need is denoted as 1. Transitions between first and second time points are denoted as 0→0, etc.

TABLE 1 -

Baseline Characteristics and Prevalence of Social Risk Factors

Characteristics	Total (N=269) [n (%)]
Age (y)	
18–44	60 (22.3)
45–64	156 (58.0)
≥65	53 (19.7)
Sex	
Female	158 (58.7)
Race	
American Indian/Alaska Native	68 (25.3)
Hispanic or Latino	137 (50.9)
Non-Hispanic White	41 (15.2)
Non-Hispanic African American	13 (4.8)
Other	10 (3.7)
Spanish-speaking	106 (39.4)
Insurance payer	
Commercial insurance	103 (38.3)
Indian Health Service insurance	9 (3.4)
Medicaid	41 (15.2)
Medicare	44 (16.4)
Self-pay	67 (24.9)
No insurance	2 (0.7)
Unknown	3 (1.1)
Estimated annual household income, by self-report	
None	25 (9.3)
$1–$9999	66 (24.5)
$10,000–$19,999	68 (25.3)
$20,000–$24,999	33 (12.3)
>$25,000	49 (18.2)
Missing	28 (10.4)
Education	
Less than high school	100 (37.3)
High school or General Educational	
Development	54 (20.2)
Some college or higher	114 (42.5)
Marital status	
Married	90 (33.6)
Living with a partner	33 (12.3)
Separated or divorced	71 (26.5)
Widowed	19 (7.1)
Never married	55 (20.5)

Characteristics	Total (N=269) [n (%)]
Employment	
Employed/self-employed	116 (43.1)
Homemaker/student/retired	80 (29.7)
Unemployed/unable to work	73 (27.1)
Ever homeless	42 (15.6)
Diabetes	89 (33.1)
Cardiovascular disease	13 (4.8)
Depression	69 (25.7)
Chronic kidney disease	30 (13.5)
Body mass index (kg/m^2) [(mean (SD)]	32.6 (7.3)
Tobacco use	
Current smoker	80 (29.9)
Former smoker	62 (23.1)
Never smoked	126 (47.0)
Alcohol use	
Never	135 (50.2)
Monthly or less	62 (23.1)
2–4 times/month	38 (14.1)
2–3 times/week	20 (7.4)
≥4 times/week	14 (5.2)
Use of illegal drugs	26 (9.7)
Social risk factors at baseline	
Housing	43 (16.1)
Transportation	65 (24.4)
Food	88 (32.7)
Clothing	67 (24.9)
Health care	108 (40.2)
Utilities	146 (54.7)
Debts	130 (49.6)

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TABLE 2 -

Relative Rankings of Social Risk Factors

	Baseline to 6 Months	6–12 Months					
Risk Factor A	**Risk Factor B**	**ORAB (95% CI)**	***P***	**Relative Rank A vs. B**	**ORAB (95% CI)**	***P***	**Relative Rank A vs. B**
Housing	Transportation	0.7 (0.4–1.4)	0.38	ND	0.8 (0.4–1.5)	0.55	ND
	Food	2.3 (1.3–4.1)	0.002	Higher*	2.5 (1.4–4.6)	0.002	Higher*
	Clothing	3.4 (1.8–6.8)	0.00005	Higher*	2.2 (1.2–4.2)	0.006	Higher†
	Health care	4.7 (2.6–9.1)	<0.00001	Higher*	3.5 (1.9–6.6)	<0.00001	Higher*
	Utilities	3.5 (2.0–6.3)	<0.00001	Higher*	3.4 (2.0–6.2)	<0.00001	Higher*
	Debts	3.4 (1.9–6.1)	<0.00001	Higher*	2.9 (1.6–5.6)	0.0001	Higher*
Transportation	Food	2.8 (1.6–5.2)	0.00009	Higher*	3.0 (1.6–5.8)	0.0001	Higher*
	Clothing	3.4 (1.9–6.3)	0.00001	Higher*	2.4 (1.4–4.5)	0.002	Higher*
	Health care	4.9 (2.8–9.3)	<0.00001	Higher*	3.1 (1.8–5.4)	<0.00001	Higher*
	Utilities	4.7 (2.6–9.1)	<0.00001	Higher*	3.7 (2.1–6.8)	<0.00001	Higher*
	Debts	4.1 (2.3–7.8)	<0.00001	Higher*	2.9 (1.7–5.2)	0.00003	Higher*
Food	Clothing	1.2 (0.7–2.0)	0.62	ND	0.9 (0.5–1.5)	0.68	ND
	Health care	2.0 (1.2–3.3)	0.004	Higher†	1.4 (0.9–2.3)	0.2	ND
	Utilities	1.5 (1.0–2.3)	0.06	ND	1.5 (0.9–2.4)	0.09	ND
	Debts	1.4 (0.9–2.2)	0.16	ND	1.2 (0.7–1.9)	0.57	ND
Clothing	Health care	1.7 (1.1–2.7)	0.03	Higher†	1.7 (1.0–2.9)	0.06	ND
	Utilities	1.3 (0.9–2.0)	0.19	ND	1.7 (1.0–2.8)	0.03	Higher†
	Debts	1.2 (0.8–1.9)	0.39	ND	1.3 (0.8–2.2)	0.29	ND
Health care	Utilities	0.9 (0.6–1.3)	0.57	ND	1.1 (0.7–1.7)	0.75	ND
	Debts	0.8 (0.5–1.2)	0.27	ND	0.8 (0.5–1.4)	0.54	ND
Utilities	Debts	0.9 (0.5–1.4)	0.65	ND	0.8 (0.5–1.2)	0.29	ND

*Remained significant after Bonferroni correction for multiple comparisons.

†Did not remain significant after Bonferroni correction.

CI indicates confidence interval; ND, no difference; OR, odds ratio.