Behavioral Conformity to Patterns of Adapting to Health and Effects on Medical Expenditures

Frederick H. Navarro

May, 2017

Highlights

- Health-related behavior has known effects on medical expenditures
- The effects of patterns of health-related behavior on expenditures are unknown
- Increasing conformity to the Patterns of Adapting to Health (PATH) directly and indirectly influence medical expenditures through effects on sex and age.
- Age and sex effects on medical expenditures are partly due to PATH effects
- Total PATH effects on medical expenditures are comparable to the impacts of obesity

Abstract

Sex and age are valid predictors of medical expenditures. Recent research has identified the Patterns of Adapting to Health (PATH) as valid predictors of medical expenditures after controlling for sex and age. However, indirect effects of patterns of health-related behavior on medical expenditures remain unexplored. Equating patterns of health-related behavior to attractors within a phase space defined by multidimensional health behavior, this study explored the direct and indirect effects on population medical expenditures as participant health-related behaviors increasingly conform to these patterns. The study utilized a sample of 3,955 adult health plan members aged 18 to 64. Self-reported health-related behaviors were captured with a short inventory obtained from a mail survey. One year's total allowed medical claims, age, and sex where drawn from member records. Inventory data were used to assign participants to one of the nine PATH. Computed posterior probabilities of pattern assignment assessed participant's degree of conformity to all nine of the patterns. Multiple regression analysis was used to decompose pattern conformity direct and indirect effects on total medical claims. Six of nine patterns had positive direct effects on medical claims with increasing conformity to the patterns after controlling for sex and age; other patterns had only indirect effects via sex, via age, or via sex and age. Largest total effects on medical claims were associated with increasing conformity to one pattern with mean per person expenditure comparable to 82-year-old obese females. Results suggest that health behavioral effects on population medical expenditures extend beyond specific behaviors to larger patterns of health-related behavior exerted directly and indirectly through sex and age.

JEL classifications: C1; C3; I1; Y4

Health-related behavior has been linked to both direct and indirect effects on medical expenditures. Frequent healthcare seeking behavior has been shown to directly increase medical costs (Koskela, Ryynanen, & Soini, 2010; Morriss, Kai, Atha, Avery, Bayes, Franklin, et al., 2012). Avoiding or delaying healthcare has been associated with decreased health service use (Green, Polen, Leo, Janoff, Anderson, Weisner et al., 2010; Rupper, Konrad, Garrett, Miller, & Blazer, 2004).

Multiple domains of health-related behavior such as poor diet or sedentary behavior impact medical expenditures indirectly by contributing to chronic disease (Thorpe, Ogden, & Galactionova, 2010). A lack of physical activity and poor dietary habits impact medical expenditures by contributing to higher BMI, obesity (de Rezende, Rey-López, Matsudo, & do Carmo Luiz, 2014; Jacka, Sacks, Berk, & Allender, 2014) and cardiovascular disease (Guijing Pratt, Macera, Zhi-Jie, & Heath, 2004).

Health-related behavior indirectly influences medical expenditures through impacts on aging (Hobbs & Fowler, 2014; Stewart, 2004). Smoking contributes to depression and anxiety disorders (Jamal, Does, Penninx, & Cuijpers, 2011) advancing biological aging (Mitsumune, Senoh, Nishikawa, Adachi, & Kajii, 2009; Wolkowitz, Epel, Reus, & Mellon, 2010) further contributing to increased medical expenditures (Bertakis & Azari, 2010; Nakamura, Okamura, Hayakawa, Kanda, Okayama et al., 2010). Physical activity, on the other hand, slows biological aging (Boyland, 2008) and the subsequent growth of medical expenditures (Ackermann, Williams, Nguyen, Berke, Maciejewski, & LoGerfo, 2008; Brown, Hockey, & Dobson, 2008; Katzmarzyk, Gledhill, & Shephard, 2000).

Patterns of Health-Related Behavior

Cluster-based studies of health-related behaviors consistently identify different numbers of patterns underlying those behaviors (Palsdottir, 2008; Rovniak, Sallis, Saelens, Frank, Marshall, Norman, et al., 2010; Schneider, Huy, Schuessler, Diehi, & Schwarz, 2009). Patterns of health-related behavior identified via cluster analysis have been shown to directly influence health and contribute to morbidity and mortality (Chang, Lu, Lan, & Wu, 2013; Charreire, Casey, Salze, Kesse-Guyot, Simon, & Chaix et al., 2010).

A number of indirect influences between patterns of health-related behaviors and medical expenditures can be hypothesized. Patterns of health-related behavior have been linked to disorders associated with aging (Axén, Bodin, Bergström, Halasz, Lange, Lövgren et al., 2011; Charreire et al., 2010; Verger, Lions, & Ventelou, 2009) leading to increased medical expenditures (Choi, Lee, Matejkowski, & Baek, 2014; Finkelstein, Fiebelkorn, & Guijing, 2003; Xuemei, 2004). Likewise, cluster-based research has found that females and males tend to cluster into different health-related behavior patterns (Charreire et al., 2010; Schneider et al., 2009) which may therefore account for a portion of the medical expenditure differences between males and females (Alemayehu & Warner, 2004; Bertakis & Azari, 2010; CHS, 2012; NHED, 2012).

Complex Adaptive Systems Theory

Complex systems theory has been used to interpret the patterns at the center of clustered groups as self-organized behavior around attractors with cluster group membership defining the basins of attraction (Mandara, 2003). Complex adaptive systems theory applied to explaining population health (Jayasinghe, 2011) has characterized a population of interacting individuals as adapting to a local environment driven by health-related micro-motives. The population as a whole, however, demonstrates macro-level behavior characterized by emergent, self-organized patterns (Miller & Page, 2007). Relative to clustered groups, the centroids have been argued to represent the self-organized emergent macro-behavior of a population system as a whole located on the attractors with individuals residing at different distances from each cluster group center (Ben-Israel & Iyigun, 2008; Boguslauskas & Adlytė, 2010). Individuals thus conform to the characteristics of the attractors at the center of each cluster group to different degrees (Hidayat, Shakaff, Ahmad, & Adom, 2010). This increasing conformity have been shown to impact medical expenditures directly (Navarro, 2014).

The purpose of this study was to explore the total effects of adult increasing conformity to patterns of health-related behavior on medical expenditure levels by hypothesizing the existence of both direct and indirect effects. Indirect effects were hypothesized to exist by way of the pattern associations with sex and age. Thus, the total effect of patterns of health-related behavior on medical expenditures would consist of both direct and indirect effects via sex and age.

The method of decomposing correlations between variables into direct and indirect effects is path analysis (Alwin & Hauser, 1975). Path analysis uses the outputs of staged multiple regression analyses to separate direct and indirect effects of multiple predictors on a criterion variable (Aremu & Lawal, 2009; Bond & Ng, 2004).

Methods

Participants

A random sample of 4,032 adult members with ages 18 to 64 of a Florida health insurance plan were drawn from a larger archival data set of 6,917 cases (BCBSF, 2004). The data set included adult member responses to measures of health-related behavior to a mailed questionnaire from 2003 linked to member's records and historical claims history. After data cleaning and removal of univariate and multivariate outliers (Tabachnick & Fidell, 2007) the sample size was reduced to 3,955 cases. The sample was weighted to reflect the sex and age composition of the adult Florida population in 2003.

Measures

Age and Sex. Member age in years and sex were drawn from member records. Sex was dummy coded with females coded as "1" and males coded as "0".

Total Medical Claims. Medical claims from 2001 were extracted from member medical records and summed to represent total claims in U.S. dollars. The total claims variable was normalized using a log10 transformation (Bertakis & Azari, 2010).

Patterns of Adapting to Health. Member health-related behaviors were assessed using the first 15 items of the Patterns of Adapting to Health (PATH) Inventory (Navarro, 2011). The PATH Inventory measures adult agreement or disagreement with a set of statements describing behavioral responses to different health-related contexts using five point Likert-type items. The face validity of the PATH Inventory items has been supported by many healthcare research professionals who have applied the PATH Inventory since 1988. The inventory items are posited to capture adaptive behavioral tendencies represented in language (Navarro, 2013; 2015) to health-related contexts previously shown to effect medical expenditures. Such heath-related contexts include health information seeking (Liechty, 2011), participation in vigorous physical activity (Ackermann, Williams, Nguyen, Berke, Maciejewski et al., 2008), attention to nutrition information (Murray, 1994), healthcare seeking (Bhatia. & Cleland, 2001) or avoidance (Green et al., 2010), responsibility for family health (Basu & Meltzer, 2005), concern about healthcare costs (Zivin, Ratliff, Heisler, Langa, & Piette, 2010), and beliefs around the competence of physicians (Thom & Pawlson, 2004).

A single variable with values 1 through 10 identifies a participant's classification into one of the nine PATH and a no pattern group. The PATH were previously validated across different U.S. geographic regions (Navarro, 1990). Prior research has associated the PATH with small effects on self-reported health service use (Navarro, 1988) and health service use of seniors (Navarro, 1999).

Pre-Analysis

Multiple Regression Analysis. Evaluating the predictive effects the PATH Inventory measures on medical expenditures was accomplished through a single standard multiple regression analysis. The 15 PATH Inventory measures were regressed on normalized total medical claims while controlling for sex and age.

Discriminant Function Analysis. Calculable estimators of central pattern tendencies are a case's Euclidean distance from group centroids (Dixon & Brereton, 2009) or posterior probabilities (Carvalho & Lawrence, 2008; Klecka, 1980). Posterior probabilities increase as cases approach and increasingly conform to a cluster group's central pattern (e.g., centroid) as compared to Euclidean distances which decrease. Of the two measures, the posterior probabilities were selected to better reflect the effects of increasing proximity to group central patterns on increasing medical claims (positive correlation) or decreasing medical claims (negative correlation).

Posterior probabilities of PATH group membership were obtained through a standard discriminant function analysis (DFA), where the PATH Inventory items were entered as independent variables and the PATH nominal group codes entered as the grouping variable (Tabachnick & Fidell, 2007). The obtained posterior probabilities of PATH group membership were subsequently entered into each multiple regression analysis representing the effects of each PATH as participant's pattern of response to the inventory measures increasingly conformed to each PATH.

Primary Analysis

Stepped Multiple Regressions and Path Analysis. Following procedures described by Pedhazur (1982), three multiple regression analyses were used to decompose predictor direct and indirect effects on total medical claims described by the following equations:

1) $\text{Sex}_2 = a + \beta_{2P}X_P + e_2$
2) $\text{Age}_3 = a + \beta_{32}X_2 + \beta_{3P}X_P + e_3$
3) $\text{Total medical claims}_4 = a + \beta_{42}X2 + \beta_{43}X_3 + \beta_{4P}X_P + e_4$

where:

- a = constant
- X_P = participant posterior probabilities of PATH group membership
- X_2 = sex
- X_3 = age in years
- X_4 = total medical claims
- β_{2P} = the direct effect of PATH on sex
- β_{32} = the direct effect of sex on age
- β_{3P} = the direct effect of PATH on age
- β_{42} = the direct effect of sex on total medical claims
- β_{43} = the direct effect of age on total medical claims
- β_{4P} = the direct effect of PATH on total medical claims
- e_i = error terms 2 through 4

These multiple regression equations are depicted in Figure 1. Beta coefficients derived from these multiple regressions were used to decompose the correlation between participant posterior probabilities of PATH group membership and total medical expenditures into direct and indirect effects (Figure 2). This was a partial path analysis because correlations between the posterior probabilities of each PATH were left unanalyzed due to the complexity of accounting for their multiple indirect effects.

Statistical analyses were conducted using PSPP (2007) and SPSS (IBM SPSS, 2012) at $p < .001$ to min-

Figure 1

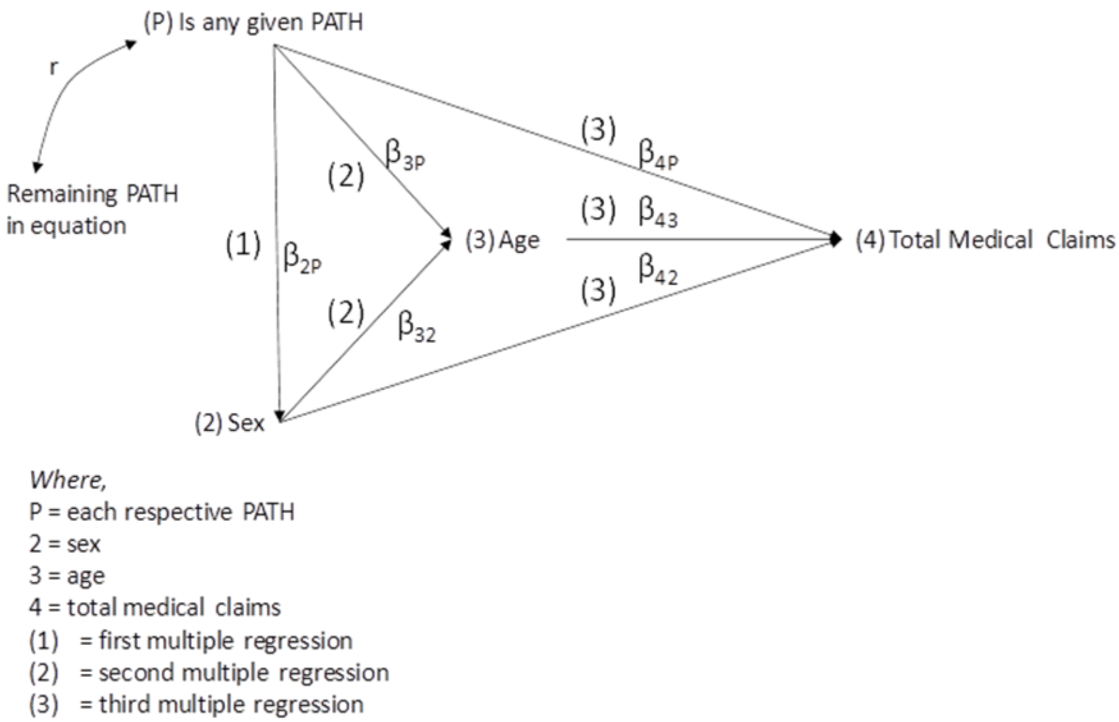

Figure 1. Analytic model specifying the beta coefficients obtained from three standard multiple regression analyses. In all multiple regressions, participants in the "no pattern" group were used as the control group. In the first multiple regression (1) the nine PATH posterior probabilities are regressed on sex. From this multiple regression nine beta coefficients (β_{2P}) identify the linear effects of each PATH posterior probabilities on sex while controlling for the effects of the remaining PATH. In the second multiple regression (2) the nine PATH posterior probabilities and sex are regressed on age in years. From this second multiple regression nine beta coefficients (β_{3P}) each identify the linear effects of specific PATH posterior probabilities while controlling for sex and the remaining PATH, and the sex beta coefficient (β_{32}) identifies the linear effect of sex on age controlling for the PATH effects. In the third multiple regression analysis the nine PATH posterior probabilities, sex, and age are regressed on normalized total medical claims. The beta coefficients obtained from this analysis include the nine PATH posterior probabilities predicting medical claims (β_{4P}), a beta for sex predicting medical claims (β_{42}), and a beta for age predicting medical claims (β_{43}) while controlling for the effects of remaining variables in the equation.

imize familywise error. Assuming a minimal effect size of $R^2 = .012$ (Navarro, 1988), twelve independent variables, and the available sample size, the power of the test ($1 - \beta$) was near 1.0 (Faul, Erdfelder, Buchner, & Lang, 2009). While some warn that too high power may result in trivial findings (Tabachnick & Fidell, 2007), the use of an extremely strict p-value served to minimize this.

Results

Descriptive statistics by sex, membership in the PATH, mean age and mean total medical claims were calculated and shown in Table 1. Means and standard deviations for the measures of health-related behaviors were calculated and shown in Table 2. The skewness and kurtosis statistics indicated that the responses to the measures of health-related behavior satisfied or near satisfied assumptions of normality. The health behavioral characteristics of each PATH are shown in Table 3 using the measures of health-related behavior expressed as mean T-scores.

PATH Associations with Sex and Age

The associations between PATH and sex and PATH and ages were tested to determine if the assumption of possible PATH indirect effects on medi-

Figure 2

$$\overset{DE_p}{r_{P4} = \beta_{4P}} + \overset{IE_{p\text{->}sex}}{\beta_{42}\beta_{2P}} + \overset{IE_{p\text{->}age}}{\beta_{43}\beta_{3P}} + \overset{IE_{p\text{->}sex\text{->}age}}{\beta_{43}\beta_{32}\beta_{2P}}$$

Where,
P = each respective PATH
2 = sex
3 = age
4 = total medical claims
DE_p = direct effect of specific PATH on total medical claims controlling for all other effects
$IE_{p\text{->}sex}$ = indirect effect of specific PATH on total medical claims via relationship to sex
$IE_{p\text{->}age}$ = indirect effect of specific PATH on total medical claims via relationship to age
$IE_{p\text{->}sex\text{->}age}$ = indirect effects of specific PATH on total medical claims via sex relationships with age and age relationships to total medical claims.

Figure 2. Path Analysis. According to Pedhazur (1980), the correlations between the PATH and total medical expenditures (r_{P4}) can be decomposed into direct and indirect effects. The beta coefficients obtained from the three multiple regression analyses described in Figure 1 were used to obtain these effects as follows: the direct effect of each PATH on total medical claims is identified by the beta (β_{4P}), the indirect effect of each PATH on total medical claims via effects on sex is identified by the product of two betas ($\beta_{42} \cdot \beta_{2P}$), the indirect effects of each PATH on total medical claims via effects on age is the product of two betas ($\beta_{43} \cdot \beta_{3P}$), with the remaining PATH effects on medical expenditures coming via PATH effects on sex, sex effects on age, and age effects on total medical claims ($\beta_{43} \cdot \beta_{32} \cdot \beta_{2P}$).

cal claims through them was justified. A cross-tabulation analysis of the two nominally-coded variables returned a statistically significant chi square, χ^2 (9, n = 3,955) = 54.8, $p < .0001$, Cramer's V = .12, supporting the association of sex and PATH membership. A one way ANOVA comparing mean age across the PATH also supported the association between PATH membership and age, F(9, 3945) = 15.3, $p < .0001$, ω^2 = .032 (Table 4).

Health-Related Behaviors Predicting Total Medical Claims

The PATH Inventory measures of health-related behavior regressed on normalized total medical claims were statistically significant, F(15, 3939) = 17.7, $p < .0001$, R^2 (Adjusted R^2) = .06(.06) and after controlling for age and sex. F(17, 3937) = 28.3, $p < .0001$, R^2 (Adjusted R^2) = .11(.10). Six of the 15 PATH Inventory measures were found to have statistically significant effects on total medical claims after controlling for age and sex as reported in Table 5.

Calculation of Posterior Probabilities of PATH Group Membership

The absence of univariate and multivariate outliers from the data and the near normality of the independent variables satisfied the major assumptions of discriminant function analysis (Tabachnick & Fidell, 2007). The first canonical discriminant function was significant (λ = .05, χ^2 [126, Weighted N = 3,945] = 12,114.45, $p < .0001$, canonical R = .76) as was the second canonical discriminant function (λ = .11, χ^2 [104, Weighted N = 3,945] = 8,714.60, $p < .0001$, canonical R = .71). Remaining discriminant functions were significant at $p < .001$ and accounted for diminishing proportions of variance. The descriptive statistics for the calculated posterior probabilities across the PATH are shown in Table 6.

Review of the PATH mean posterior probabilities for each PATH and the distribution statistics for each showed differences in the spread of participants around each group's central pattern. The Health Contented (HC) PATH had the highest mean posterior

Table 1
Descriptive Statistics (n = 3,955)

Variable	%
Sex	
Female	51.5
Male	48.5
Patterns of Adapting to Health (PATH)	
Critically Discerning (CD)	.8
Health Contented (HC)	1.6
Wisely Frugal (WF)	17.4
Traditionalist (T)	2.1
Family Centered (FC)	17.9
Family Driven (FD)	9.1
Healthcare Driven (HD)	15.3
Independently Healthy (IH)	15.8
Naturalist (N)	11.4
No pattern (NP)	8.7
	M(SD)
Age in years	42.0 (12.4)
Total Claims ($)	5640.6 (11,076.0)

probabilities (M = .93) and a highly negatively skewed distribution with an extreme peak indicating that participants within this PATH are generally in very close proximity to the group's central pattern (e.g., centroid). The Independently Healthy (IH) PATH had the second highest mean posterior probabilities (M = .80) and the next most negatively skewed and peaked distribution, indicating that participants within this PATH also reside relatively close to the group's central pattern, although not to the degree of the HC PATH. This is in contrast to the Family Centered (FC) PATH with lower mean posterior probabilities (M = .68) and the spread of posterior probabilities following a more normal distribution.

Correlations between normalized total medical claims; dummy coded sex, age in years, and PATH posterior probabilities appear in Table 7.

Stepped Multiple Regression Analysis

The three standard multiple regression analyses were conducted and the results of all three shown in Table 7. All three met the criterion for statistical significance. Of the PATH prediction of females versus males in multiple regression analysis (1), three PATH had statistically significant effects at $p < .001$: Health Contented, Healthcare Driven, and

Table 2
PATH Inventory Descriptive Statistics (n = 3,955)

PATH Inventory Item Summaries	M (SD)*	95% CI	(1)	(2)
I seek health information	3.90 (1.08)	[3.87, 3.93]	-0.87	0.30
I consider price when selecting physicians	3.21 (1.35)	]3.17, 3.25]	-0.25	-1.14
I take health as it comes	2.44 (1.36)	[2.40, 2.48]	0.49	-1.12
I shop for healthcare to save money	2.92 (1.29)	[2.88, 2.96]	0.02	-1.01
I take part in active or competitive sports	2.47 (1.37)	[2.43, 2.52]	0.39	-1.13
Others make family health decisions	1.65 (1.09)	[1.62, 1.69]	1.62	1.64
I like making family health decisions	4.00 (1.15)	[3.97, 4.04]	-1.00	0.21
Expense prevents me from seeking care	3.04 (1.47)	[3.00, 3.09]	-0.08	-1.43
Family responsible for own health	2.99 (1.42)	[2.95, 3.03]	-0.05	-1.29
I compare hospitals before being hospitalized	3.36 (1.45)	[3.32, 3.41]	-0.40	-1.22
I seek information on diet and nutrition	4.01 (1.02)	[3.98, 4..04]	-0.97	0.49
I put off care seeking until very sick or ill	3.25 (1.47)	[3.21, 3.30]	-0.31	-1.35
Physician competence less than expected	2.78 (1.19)	[2.74, 2.82]	0.12	-0.82
When sick I rely on others for health decisions	2.15 (1.25)	[2.11, 2.19]	0.72	-0.74
I am satisfied if family has average health	2.47 (1.29)	[2.43, 2.51]	0.40	-1.09

*Likert Item: 1-strongly disagree to 5-strongly agree
(1) - skewness, (2) - kurtosis

Table 3

Patterns of Adapting to Health (PATH) Mean T-Scores

	PATH*									
PATH Inventory Items Summaries	CD	HC	WF	T	FC	FD	HD	IH	N	NP
I seek health information	45.6	32.8	53.5	37.8	48.6	46.2	53.1	53.6	52.2	44.8
I consider price when selecting physicians	41.7	50.0	56.0	37.7	47.2	49.2	46.9	48.9	51.7	52.2
I take health as it comes	60.0	63.3	55.4	63.1	50.5	47.8	44.6	42.9	45.8	58.6
I shop for healthcare to save money	51.6	43.1	54.4	43.2	47.8	50.8	46.3	50.1	51.3	50.5
I take part in active or competitive sports	47.6	39.0	51.3	43.8	45.9	51.7	44.1	61.6	42.0	54.6
Others make family health decisions	56.2	44.5	47.2	53.9	48.7	51.5	47.0	48.2	47.4	55.1
I like making family health decisions	42.3	49.5	53.1	43.2	54.7	47.1	50.6	49.2	48.7	46.5
Expense prevents me from seeking care	48.0	60.6	59.3	43.2	50.9	42.2	40.9	45.8	53.4	53.6
Family responsible for own health	41.1	57.6	53.5	57.6	39.3	39.8	56.1	52.2	50.9	53.7
I compare hospitals before being hospitalized	50.3	50.5	52.8	37.0	49.7	40.7	48.0	54.2	56.9	46.4
I seek information on diet and nutrition	35.5	40.6	49.6	41.1	50.1	47.2	52.4	54.7	52.9	46.2
I put off care seeking until very sick or ill	57.4	58.3	55.9	53.9	51.4	43.9	39.7	46.6	54.4	54.4
Physician competence less than expected	58.6	59.0	49.9	50.2	47.3	47.0	45.7	50.7	56.1	53.7
When sick I rely on others for health decisions	51.9	48.9	48.9	51.9	44.8	48.7	48.9	49.0	52.0	59.5
I am satisfied if family has average health	50.6	57.2	55.6	50.0	44.0	53.6	46.8	45.3	52.5	53.2

*CD = Critically Discerning, HC = Health Contented, WF = Wisely Frugal, T = Traditionalist, FC = Family Centered, FD = Family Driven, HD = Healthcare Driven, IH = Independently Healthy, N = Naturalist, NP = no pattern

Naturalist. In multiple regression analysis (2) the effects of six out of nine of the PATH reached $p < .001$ in the prediction of age; namely, Wisely Frugal, Family Centered, Family Driven, Healthcare Driven, Independently Healthy, and Naturalist. In multiple regression analysis (3) the effects of five of the nine PATH; namely, Traditionalists, Family Centered, Healthcare Driven, Independently Healthy, and Naturalist, as well as age and sex reached the $p < .001$ level of significance.

Following the analytic model and equations specified in Figures 2 and 3, the required statistically significant beta coefficients from each of the multiple regression analyses were used to calculate direct and

Table 4

Patterns of Adapting to Health (PATH), Sex, and Age

	Sex %***		Age***	
PATH	Female	Male	M (SD)	95%CL
Critically Discerning (CD)	0.7	1.0	42.1 (10.9)	[38.2, 46.0]
Health Contented (HC)	2.2	0.9	36.4 (14.0)	[32.9, 39.9]
Wisely Frugal (WF)	16.6	18.2	41.0 (13.4)	[40.0, 42.0]
Traditionalist (T)	2.5	1.7	38.4 (14.2)	[35.3, 41.6]
Family Centered (FC)	19.2	16.6	42.1 (10.0)	[41.3, 42.8]
Family Driven (FD)	8.2	10.0	42.5 (10.8)	[41.3, 43.6]
Healthcare Driven (HD)	17.0	13.5	43.5 (13.7)	[42.4, 44.6]
Independently Healthy (IH)	13.6	18.2	43.0 (11.7)	[42.1, 43.9]
Naturalist (N)	12.4	10.2	44.9 (11.6)	[43.8, 46.0]
No pattern (NP)	7.6	9.8	36.4 (13.2)	[35.0, 37.8]

$^{*}p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table 5

PATH Inventory Predicting Total Medical Claims Controlling for Age and Sex

	B	SE	β	p	95%CL
(Constant)	2.96	0.04	0.00	**	[2.88, 3.05]
I seek health information	-0.03	0.01	-0.04	**	[-0.04, -0.01]
I consider price when selecting physicians	0.00	0.01	-0.01		[-0.01, 0.01]
I take health as it comes	-0.04	0.01	-0.08	**	[-0.05, -0.03]
I shop for healthcare to save money	0.01	0.01	0.01		[-0.01, 0.02]
I take part in active or competitive sports	-0.02	0.01	-0.04	**	[-0.03, -0.01]
Others make family health decisions	-0.01	0.01	-0.01		[-0.02, 0.01]
I like making family health decisions	0.04	0.01	0.07	**	[0.02, 0.05]
Expense prevents me from seeking care	0.00	0.01	-0.01		[-0.02, 0.01]
Family responsible for own health	0.00	0.01	-0.01		[-0.02, 0.01]
I compare hospitals before being hospitalized	0.01	0.01	0.02		[0.00, 0.02]
I seek information on diet and nutrition	0.02	0.01	0.02		[0.00, 0.03]
I put off care seeking until very sick or ill	-0.04	0.01	-0.08	**	[-0.05, -0.02]
Physician competence less than expected	-0.01	0.01	-0.01		[-0.02, 0.01]
When sick I rely on others for health decisions	-0.04	0.01	-0.07	**	[-0.05, -0.02]
I am satisfied if family has average health	0.01	0.01	0.02		[0.00, 0.03]
Age	0.01	0.00	0.21	**	[0.01, 0.01]
Female	0.11	0.02	0.08	**	[0.07, 0.15]

$F(17, 3937) = 28.3$, $p < .0001$, R^2(Adjusted R^2) = .11 (.10)

*$p < .005$, **$p < .001$

indirect effects of the PATH on total medical claims and presented in Table 8.

Of the nine PATH posterior probabilities six had confirmed total effects on medical expenditures as the posterior probabilities increased. The Wisely Frugal PATH only had indirect effects on total medical claims through effects on age. The Traditionalist PATH only had direct effects on total claims after controlling for sex and age. The Family Driven PATH had direct effects on total medical claims, as well as indirect effects through age. The Healthcare Driven PATH had the largest total effects on medical claims supported by both a large direct effect on claims controlling for sex and age, but also via indirect effects through sex and age. The Independently Healthy PATH had the second largest total effects on medical claims supported by both a direct effect after controlling for sex and age, and via equal indirect effects via sex and age. Finally, the Naturalist PATH had the smallest total effects on medical claims also supported by small indirect effects via sex and indirect effects via age.

Mean total claims in dollars were calculated for the PATH with supported total effects on and presented in Table 9. Compared to the mean total claims for the entire sample, the size of the mean total claims difference of each PATH was consistent with the magnitude of the total effect. Participants

Table 6

Descriptive Statistics: PATH Posterior Probabilities

PATH	*M*	*SD*	Skewness	Kurtosis
CD	0.66	0.31	-0.46	-0.97
HC	0.93	0.19	-3.62	13.27
WF	0.72	0.27	-0.90	-0.23
T	0.75	0.35	-1.17	-0.24
FC	0.68	0.27	-0.69	-0.62
FD	0.61	0.30	-0.41	-1.14
HD	0.78	0.26	-1.24	0.50
IH	0.80	0.23	-1.51	1.69
N	0.68	0.28	-0.81	-0.56
NP	0.76	0.26	-1.21	0.52

Table 7

Variable Correlations (n = 3,955)

		1	2	3	4	5	6	7	8	9	10	11	12	13
1.	TotalClaims_log10	--	.25	.09	-.01	-.06	-.08	.00	.08	-.02	.12	.02	.03	-.15
2.	Age		--	-.03	-.01	-.05	-.03	-.05	.04	.02	.07	.04	.07	-.17
3.	Sex[a]			--	-.03	.06	-.03	.02	.04	-.03	.06	-.07	.04	-.04
4.	CD probabilities*				--	.00	-.05	-.01	-.02	-.01	-.05	-.06	-.02	-.02
5.	HC probabilities					--	-.06	-.02	-.08	-.06	-.07	-.08	-.06	-.05
6.	WF probabilities						--	-.08	-.19	-.22	-.25	-.18	-.10	-.08
7.	T probabilities							--	-.08	-.06	-.05	-.08	-.06	-.03
8.	FC probabilities								--	-.00	-.21	-.24	-.13	-.19
9.	FD probabilities									--	-.12	-.13	-.17	-.07
10.	HD probabilities										--	-.17	-.11	-.16
11.	IH probabilities											--	-.20	-.16
12.	N probabilities												--	-.13
13.	NP probabilities													--

classified as Healthcare Driven were associated with the largest mean increase in total claims per person of $1,619 dollars. In contrast, participants classified as Independently Healthy were associated with lower mean total claims of $494 dollars per person. The second highest mean increase of $851 dollars in total claims per person was associated with participants classified as Naturalist; participants classified as Family Centered had higher mean total claims per person of $751 dollars. The smallest impacts on mean total claims were increases of $418 and decreases of $156 dollars associated with participants classified as Traditionalist and Wisely Frugal; respectively.

Discussion

This study has provided evidence that health behavioral effects on medical expenditures are not limited to distinct health-related behaviors but extend to embedded patterns of health-related behavior underlying and organizing the milieu of adult health-related behavior. The hypotheses that patterns of health-related behavior have both direct and indirect effects on medical expenditures as adult health-related behavior increasingly emulates them were partially supported based on the PATH solution. A unique aspect of the study was its focus on the effects associated with each pattern's *configuration* as individual behavior increasingly reflected them as opposed to the effects of membership in groups defined by patterns of health behavior.

This study required 62 individual tests of statistical significance. Based on the critical value of $p < .001$ used, the familywise error for the entire study was $p_{\text{family}} < .06$.

The literature is mixed on the accuracy and reliability of self-reported health-related behavior in measuring how much a behavior occurs (Baier, Calonge, Cutter, McClatchey, Schoentgen et al., 2000; Dowling-Guyer, Johnson, Fisher, Needle, Watters et al., 1994; Gorber, Schofield-Hurwitz, Hardt, Levasseur, & Tremblay, 2009; Rauscher, Johnson, Cho, & Walk, 2008). The measures of health-related behavior used in this study were better understood to represent tendencies in behavioral response and affective salience of described actions across health-related contexts encoded in language semantics (Lyons, Mattarella-Micke, Cieslak, Nusbaum, Small, & Beilock, 2010; van Elk, van Schie, & Bekkering, 2009) as opposed to estimating how much the behaviors occurred. However, the predictive relationship of six PATH Inventory measures to medical claims consistent with the di-

Table 8

Multiple Regressions: Posterior Probabilities of PATH Membership Predicting Sex, Predicting Age Controlling for Sex, and Predicting Total Claims Controlling for Sex and Age

	(1)		(2)		(3)	
Variables	*β*	*p*	*β*	*p*	*β*	*p*
CD posterior probabilities	-0.02	*ns*	0.04	*	0.03	*ns*
HC posterior probabilities	0.08	***	0.04	*	0.00	*ns*
WF posterior probabilities	0.01	*ns*	0.17	***	0.06	*
T posterior probabilities	0.04	*ns*	0.03	*ns*	0.06	***
FC posterior probabilities	0.07	*	0.22	***	0.17	***
FD posterior probabilities	0.00	*ns*	0.15	***	0.06	*
HD posterior probabilities	0.09	***	0.25	***	0.20	***
IH posterior probabilities	-0.02	*ns*	0.23	***	0.13	***
N posterior probabilities	0.07	***	0.22	***	0.10	***
Sex	DV		-0.04	*	0.09	***
Age			DV		0.23	***
Total Medical Claims_log10					DV	
R^2	.02		.04		.10	
Adjusted R^2	.02		.04		.10	
F	7.53	***	17.65	***	39.81	***

$^*p < .05$, $^{**}p < .01$, $^{***}p < .001$

rectionality of the described behavior supports their link to actual behavioral tendencies. The study was also strengthened by the use of age, sex, and historical medical claims expenditures drawn from member records. The effect sizes obtained were small, but consistent with effect sizes associated with disease predictors of medical expenditures (Druss, Rosenheck, & Sledge, 2014). The study had few threats to internal validity, and the external validity was strengthened by weighting the sample to the demographics of the Florida population at that time.

Table 9

*PATH Direct and Indirect Effects on Total Claims**

PATH (p)	DE_p	$IE_{p \text{-> sex}}$	$IE_{p \text{-> age}}$	Total Effect
CC	-	-	-	-
HC	-	-	-	-
WF	-	-	0.04	0.04
T	0.06	-	-	0.06
FC	0.17	-	0.05	0.22
FD	0.06	-	0.05	0.11
HD	0.20	0.01	0.06	0.26
IH	0.13	0.05	0.05	0.24
N	0.10	0.01	0.05	0.15

$^*IE_{p\text{->sex->age}} < .00$

The study had several key weaknesses. While there are examples of research that delivered significant contributions using medical expenditure data as old as nine years (Aljadhey, 2012; Bernard, Cowan, Selden, Cai, Catlin & Heffler, 2012), the present study went considerably beyond that in drawing from claims data reaching back fifteen years. Studies examining medical expenditure differences also generally employ very large samples (White, Lenhart, Singhal, Insinga, Itzler et al., 2009; Hye-Young, Sung-Eun, Dae Ryong, Ji Yoon, Young Hwa et al., 2009). Compared to such studies the sample used here was small; this potentially played a role in limiting statistically significant predictive relationships to sex, age, and medical expenditures to only those patterns of health-related behavior with larger subsamples. Finally, the need to keep the path analysis manageable required leaving the correlations between posterior probabilities of membership in each of the PATH unexplored.

The total effects of the Healthcare Driven PATH stood out in the results. As adult health-related behavior increasingly conformed to the Healthcare Driven PATH with the largest direct effects on per person medical claims the increase in claims was comparable to the expenditure increase associated with 82 year old obese females (Bell, Zimmerman, Arterburn, & Maciejewski, 2011). As adult health-related behavior increasingly conformed to this pattern more frequent medical care seeking occurred as evidenced by the higher medical claims. Applied to prior research investigating frequent care seekers (Bhatia & Cleland, 2001; Demers, 1983; Mortimer & Ahlberg, 2003) the current research suggests that frequent care seeking may be part of a larger cohesive configuration of health-related behaviors. The total effects of the Healthcare Driven PATH on medical expenditures exceeded the direct effect of age. This underscores the relevance of this pattern of health-related behavior to understanding the medical expenditure levels within an adult population.

The pattern of health-related behavior identified as contributing to lowest mean total claims per person was the Independently Healthy PATH. The lowering effect exceeded the dollar savings achieved among participants in a chronic disease self-management program (Ahn, Basu, Smith, Jiang, Lorig et al., 2013) and was comparable to the increase in expenditures associated with 67 year old overweight males (Bell et al., 2011). A key distinguishing characteristic of this pattern was its strong attraction to participation in active or competitive sports consistent with the role of physical activity in slowing the impacts of biological aging and subsequently contributing to a suppression of medical expenditure growth (Ackermann et al., 2008; Brown et al., 2008; Katzmarzyk et al., 2000). The difference in the magnitude of impacts on medical expenditures between the Independently Healthy and Healthcare Driven PATH reached approximately $2,100 dollars per person. This is greater than the estimated cost difference between normal weight and obese individuals (e.g., $1,903 in 2015 dollars) (Tsai, Williamson, & Glick, 2011).

It has previously been argued that simple chronological aging is not necessarily a critical driver of increasing medical costs but rather the growing incidence of poor health and age-related disease conditions (Stewart, 2004) partially shaped by individual health-related behaviors (Hobbs & Fowler, 2014). The results of this study support the role of some patterns of health-related behavior as potential influencers of biological aging and accounting for a small portion of age relationships to medical expenditures.

A population of individuals responding and adapting to diverse healthcare contexts is a complex adaptive system. Interpreted against complex adaptive systems theory, patterns of health-related behavior represent self-organized behavior at the attractors of a population system (Mandara, 2003). This study provides evidence that as adult health-related behavior increasingly settles into these attractors both direct and indirect effects on medical expenditures occur. As individuals increasingly conform to these attractors behaviorally (Ben-Israel & Iyigun, 2008; Boguslauskas & Adlytė, 2010) and reflect their characteristics with increasing acuteness (Hidayat, Shakaff, Ahmad, & Adom, 2010) the patterns generate both direct and indirect effects on medical expenditures.

These findings are relevant to Anderson's behavioral model of health care service use (Andersen, 1995; 2008). This model recognizes the role of predisposing factors such as age, marital status, or education in shaping health care demand. Based on this research, patterns of health-related behavior within populations can be considered predisposing factors influencing health care service demand. The total effects of patterns of health-related behavior on medical expenditures are relevant to the objectives of population health management. A critical goal of population health management is to manage the financial risk of populations and medical expenditure reduction (Lynch, Forman, Graff, & Gunby, 2000). The current research suggests that to the degree adult health-related behavior conforms to population-level patterns the greater the impact on financial risk and medical expenditures result.

References

Ackermann, R. T., Williams, B., Nguyen, H. Q., Berke, E. M., Maciejewski, M. L. & LoGerfo, J. P. (2008). Healthcare cost differences with participation in a community-based group physical activity benefit for Medicare managed care health plan members. *Journal of the American Geriatrics Society*, 56(8), 1459-1465.

Ahn, S., Basu, R., Smith, M. L., Jiang, L., Lorig, K…Ory, M. G. (2013). The impact of chronic disease self-management programs: healthcare savings through a community-based intervention. *BMC Public Health*, 13(1), 1141.

Alemayehu, B. & Warner, K. E. (2004). The lifetime distribution of health care costs. *Health Services Research*, 39(3), 627-642.

Aljadhey, H. (2012). Physical inactivity as a predictor of high prevalence of hypertension and health expenditures in the United States: A cross-sectional study. Tropical Journal of Pharmaceutical Research, 11(6), 983-990.

Alwin, D. F., & Hauser, R. M. (1975). The decomposition of effects in path analysis. *American Sociological Review*, 40(1), 37-47.

Andersen, R. M. (1995). Revisiting the behavioral model and access to medical care: does it matter?. *Journal of health and social behavior*, 1-10.

Andersen, R. M. (2008). National health surveys and the behavioral model of health services use. *Medical care*, 46(7), 647-653.

Aremu, A., & Lawal, G. (2009). A path model investigating the influence of some personal-psychological factors on the career aspirations of police trainees: a perspective from Oyo State, Nigeria. *Police Practice & Research*, 10(3), 239-254.

Axén, I., Bodin, L., Bergström, G., Halasz, L., Lange, F., Lövgren, P. W., & ... Jensen, I. (2011). Clustering patients on the basis of their individual course of low back pain over a six month period. *BMC Musculoskeletal Disorders*, 12(1), 99-108. doi:10.1186/1471-2474-12-99.

Baier, M., Calonge, N., Cutter, G., McClatchey, M., Schoentgen, S., Hines, S., ... & Ahnen, D. (2000). Validity of self-reported colorectal cancer screening behavior. *Cancer Epidemiology Biomarkers & Prevention*, 9(2), 229-232.

Basu, A. & Meltzer, D. (2005). Implications of spillover effects within the family for medical cost-effectiveness analysis. *Journal of Health Economics*, 24(4), 751-773.

Bell, J., Zimmerman, F., Arterburn, D., & Maciejewski, M. (2011). Health-care expenditures of overweight and obese males and females in the medical expenditures panel survey by age cohort. *Obesity* (Silver Spring, Md.), 19(1), 228-232. doi:10.1038/oby.2010.104

Ben-Israel, A., & Iyigun, C. (2008). Probabilistic d-clustering. *Journal of Classification*, 25(1), 5-26.

Bernard, D., Cowan, C., Selden, T., Cai, L., Catlin, A., & Heffler, S. (2012). Reconciling Medical Expenditure Estimates from the MEPS and NHEA, 2007. *Medicare & Medicaid Research Review*, *2*(4), E1-E19.

Bertakis, K. D., & Azari, R. (2010). Patient gender differences in the prediction of medical expenditures. *Journal of Women's Health* (15409996), 19(10), 1925-1932. doi:10.1089/jwh.2009.1448.

Bhatia, J. C. & Cleland, J. (2001). Health-care seeking and expenditure by young Indian mothers in the public and private sectors. *Health Policy and Planning*, 16(1), 55. Retrieved December 7, 2008, from ProQuest Health and Medical Complete database. (Document ID: 405885241).

Blue Cross Blue Shield of Florida [BCBSF] (2004). Licensed data [Data file and code book]. Boguslauskas, V., & Adlytė, R. (2010). Evaluation of enterprise's performance changes within the classification process. *Economics & Management*, 1039-1045.

Bond, M., & Ng, I. (2004). The depth of a group's personality resources: Impacts on group process and group performance. *Asian Journal of Social Psychology*, 7(3), 285-300.

Booth, J. G., Casella, G., & Hobert, J. P. (2008). Clustering using objective functions and stochastic search. *Journal of the Royal Statistical Society: Series B* (Statistical Methodology), 70(1), 119-139.

Boyland, M. (2008). Exercise slows biological ageing. *Journal of The Australian Traditional-Medicine Society*, 14(1), 25.

Brown, D., Wang, G., & Safran, M. (2005). A preliminary analysis of medical expenditures among active and sedentary US adults with mental disorders. *American Journal of Health Behavior*, 29(3), 195-205.

Byrne, D. (2001). What is complexity science? Thinking as a realist about measurement and cities and arguing for natural history. *Emergence*, 3(1), 61-76.

Carvalho, L. E., & Lawrence, C. E. (2008). Centroid estimation in discrete high-dimensional spaces with applications in biology. *Proceedings of the National Academy of Sciences*, 105 (9), 3209-3214.

Cecchini, M., Sassi, F., Lauer, J. A., Lee, Y. Y., Guajardo-Barron, V., & Chisholm, D. (2010). Tackling of unhealthy diets, physical inactivity, and obesity: health effects and cost-effectiveness. *The Lancet*, 376(9754), 1775-1784.

Centers for Disease Control and Prevention [CDC] (1994, July 8). Medical-care expenditures attributable to cigarette smoking -- United States, 1993. *Morbidity and Mortality Weekly Report (MMWR)*, *43*(26), 469-472.

Centers for Medicare and Medicaid [CMS] (2013, March 9). CMS Strategy: The Road Forward 2013-2017. Retrieved from http://www.cms.gov/About-CMS/Agency-Information/CMS-Strategy/Downloads/CMS-Strategy.pdf

Centers for Medicare and Medicaid, National Health Expenditure Data [NHED] (2012, May 9). Age and Gender, 1999. Retrieved from http://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/Downloads/Agetables.pdf

Chang, W., Lu, F., Lan, T., & Wu, S. (2013). Multidimensional health-transition patterns among a middle-aged and older population. *Geriatrics & Gerontology International*, 13(3), 571-579. doi:10.1111/j.1447-0594.2012.00937.x

Charreire, H. H., Casey, R. R., Salze, P. P., Kesse-Guyot, E. E., Simon, C. C., Chaix, B. B. et al. (2010). Leisure-time physical activity and sedentary behavior clusters and their associations with overweight in middle-aged French adults. *International Journal of Obesity*, 34(8), 1293-1301. doi:10.1038/ijo.2010.39

Choi, S., Lee, S., Matejkowski, J., & Baek, Y. M. (2014). The relationships among depression, physical health conditions and healthcare expenditures for younger and older Americans. *Journal of Mental Health*, 23(3), 140-145. doi:10.3109/09638237.2014.910643

Chung, J. C., Choi, D. W., Jo, S. H., Heo, J. S., Choi, S. H., & Kim, Y. I. (2007). Malignant nonfunctioning endocrine tumors of the pancreas: predictive factors for survival after surgical treatment. *World Journal of Surgery*, 31(3), 579-585.

Demers, M. (1995). Frequent users of ambulatory health care in Quebec: the case of doctor-shoppers. *CMAJ: Canadian Medical Association Journal = Journal De L'association Medicale Canadienne*, 153(1), 37-42.

Mortimer, M., & Ahlberg, G. (2003). To seek or not to seek? Care-seeking behaviour among people with low-back pain. *Scandinavian Journal of Public Health*, 31(3), 194-203.

de Rezende, L., Rey-López, J., Matsudo, V., & do Carmo Luiz, O. (2014). Sedentary behavior and health outcomes among older adults: a systematic review. *BMC Public Health*, 14(1), 1-21. doi:10.1186/1471-2458-14-333

de Vries, H., J, Spigt, M., Metsemakers, J., M, Vermunt, J., & Kremers, S. (2008). Clusters of lifestyle behaviors: results from the Dutch SMILE study. *Preventive Medicine*, 46(3), 203-208.

Dittrich, L., & Stara, D. (2013). The impact of aging population on the rise of the health care cost in the Czech Republic. *International Advances in Economic Research*, 19(1), 11-17. doi:10.1007/s11294-012-9383-y

Dixon, S. J., & Brereton, R. G. (2009). Comparison of performance of five common classifiers represented as boundary methods: Euclidean distance to centroids, linear discriminant analysis, quadratic discriminant analysis, learning vector quantization and support vector machines, as dependent on data structure. *Chemometrics and Intelligent Laboratory Systems*, 95(1), 1-17.

Dowling-Guyer, S., Johnson, M. E., Fisher, D. G., Needle, R., Watters, J., Andersen, M., ... & Tortu, S. (1994). Reliability of drug users' self-reported HIV risk behaviors and validity of self-reported recent drug use. *Assessment*, 1(4), 383-392.

Druss, B. G., Rosenheck, R. A., & Sledge, W. H. (2014). Health and disability costs of depressive illness in a major US corporation. *American Journal of Psychiatry*.

Erlich, L. P. (2010). The effect of encounters between medical gatekeepers and patients on the doctor-patient relationship. (Doctoral dissertation). Retrieved from http://search.proquest.com/docview/250897797?accountid=14872. (250897797).

Faul, F., Erdfelder, E., Buchner, A., & Lang, A.-G. (2009). Statistical power analyses using G*Power 3.1: Tests for correlation and regression analyses. [Computer software] *Behavior Research Methods*, 41, 1149-1160. Retrieved from http://gpower.hhu.de/

Fengrong, O., Kai, L., Qian, G., Dan, L., Jinghai, L., Liwen, H., et al. (2012). An urban neo-poverty population-based quality of life and related social characteristics investigation from Northeast China. *Plos ONE*, 7(6), 1-7. doi:10.1371/journal.pone.0038861

Finkelstein, E. A., Fiebelkorn, I. C., & Guijing, W. (2003). National medical expenditures attributable to overweight and obesity: How much, and who's paying? *Health Affairs*, 22(4), 8.

Fleishman, J. A., & Cohen, J. W. (2010). Using information on clinical conditions to predict high-cost patients. *Health Services Research*, 45(2), 532-552. doi:10.1111/j.1475-

6773.2009.01080.x

Gagliardi, C., Spazzafumo, L., Papa, R., & Marcellini, F. (2012). Changes in leisure styles and satisfaction of older people: a five years follow-up. *International Journal of Aging & Human Development*, 75(3), 185-215.

Gorber, S. C., Schofield-Hurwitz, S., Hardt, J., Levasseur, G., & Tremblay, M. (2009). The accuracy of self-reported smoking: a systematic review of the relationship between self-reported and cotinine-assessed smoking status. *Nicotine & Tobacco Research*, 11(1), 12-24.

Green, C. A., Polen, M. R., Leo, M. C., Janoff, S. L., Anderson, B. M., Weisner, C. M., & Perrin, N. A. (2010). Drinking patterns, gender and health III: Avoiding versus seeking health care. *Addiction Research & Theory*, 18(2), 160-180.

Guijing, W., Pratt, M., Macera, C. A., Zhi-Jie, Z., & Heath, G. (2004). Physical activity, cardiovascular disease, and medical expenditures in U.S. adults. *Annals of Behavioral Medicine*, 28(2), 88-94.

Guo, J. J., Keck, P. E., Li, H., & Patel, N. C. (2007). Treatment costs related to bipolar disorder and comorbid conditions among Medicaid patients with bipolar disorder. *Psychiatric Services*, *58*(8), 1073-1078.

Hidayat, W., Shakaff, A., Ahmad, M., & Adom, A. (2010). Classification of agarwood oil using an electronic nose. *Sensors* (Basel, Switzerland), 10(5), 4675-4685.

Hobbs, W. R. & Fowler, J. H. (2014, January 17). Prediction of mortality using on-line, self-reported health data: empirical test of the Realage score. *PLoS ONE* 9(1): e86385. doi:10.1371/journal.pone.0086385

Husaini, B. A., Sherkat, D. E., Levine, R. S., Craun, C., Hull, P. C., Cain, V. A., et al. (2004). Age differences in the influence of race, SES, and psychiatric morbidity on healthcare utilization and expenditures. *Research in Healthcare Financial Management*, 9(1), 29-48.

Hye-Young, K., Sung-Eun, P., Dae Ryong, K., Ji Yoon, K., Young Hwa, J., Won-Jung, C., & ... Soon-Yong, K. (2009). Estimating medical expenditure associated with osteoporotic hip fracture in elderly Korean women based on the National Health Insurance Claims Database 2002–2004. *Value in Health* (Wiley-Blackwell), 12S93-S96.

IBM SPSS Statistics (2012), Version 21 [Computer software]. Armonk, New York: IBM.

Jacka, F. N., Sacks, G., Berk, M., & Allender, S. (2014). Food policies for physical and mental health. *BMC Psychiatry*, 14(1), 1 -12.

Jamal, M., Does, A., Penninx, B. H., & Cuijpers, P. (2011). Age at smoking onset and the onset of depression and anxiety disorders. *Nicotine & Tobacco Research*, 13(9), 809-819.

Jayasinghe, S. (2011). Conceptualising population health: from mechanistic thinking to complexity science. *Emerging Themes in Epidemiology*, 8(1), 2-8. doi:10.1186/1742-7622-8-2

Katzmarzyk, P. T., Gledhill, N., & Shephard, R. J. (2000). The economic burden of physical inactivity in Canada. Canadian Medical Association Journal, 163(11), 1435-40.

Klecka, W. R. (1980). Discriminant function analysis. Beverly Hills, California: SAGE Publications, Inc.

Koskela, T., Ryynanen, O., & Soini, E. J. (2010). Risk factors for persistent frequent use of the primary health care services among frequent attenders: A Bayesian approach. Scandinavian Journal of Primary Health Care, 28(1), 55-61.

Leech, R. M., McNaughton, S. A., & Timperio, A. (2014). The clustering of diet, physical activity and sedentary behavior in children and adolescents: a review. *International Journal of Behavioral Nutrition & Physical Activity*, 11(1), 1-18. doi:10.1186/1479-5868-11-4

Liechty, J. M. (2011). Health literacy: critical opportunities for social work leadership in health care and research. *Health & Social Work*, 36(2), 99-107.

Lubitz, J., Cai, L., Kramarow, E., & Lentzner, H. (2003). Health, life expectancy, and health care spending among the elderly. *New England Journal of Medicine*, 349(11), 1048-1055.

Lynch, J. P., Forman, S. A., Graff, S., & Gunby, M. C. (2000). High-risk population health management--achieving improved patient outcomes and near-term financial results. *The American Journal of Managed Care*, 6(7), 781-791.

Lyons, I. M., Mattarella-Micke, A., Cieslak, M., Nusbaum, H. C., Small, S. L., & Beilock, S. L. (2010). The role of personal experience in the neural processing of action-related language. *Brain and Language*, 112(3), 214-222.

Machlin, S. R., Chevan, J., Yu, W. W., & Zodet, M. W. (2011). Determinants of utilization and expenditures for episodes of ambulatory physical therapy among adults. *Physical Therapy*, 91(7), 1018-1029.

Mandara, J. (2003). The typological approach in child and family psychology: A review of theory, methods, and research. Clinical *Child & Family Psychology Review*, 6(2), 129-146.

Miller, J. H. & Page, S. E. (2007). *Complex adaptive systems*. Princeton, New Jersey: Princeton University Press.

Mitsumune, T., Senoh, E., Nishikawa, H., Adachi, M., & Kajii, E. (2009). The effect of obesity and smoking status on lung age in Japanese men. *Respirology* (Carlton, Vic.), 14(5), 757-760. doi:10.1111/j.1440-1843.2009.01541.x

Morriss, R., Kai, J., Atha, C., Avery, A., Bayes, S., Franklin, M., et al. (2012). Persistent frequent attenders in primary care: costs, reasons for attendance, organisation of care and potential for cognitive behavioural therapeutic intervention. *BMC Family Practice*, 13(1), 39-52. doi:10.1186/1471-2296-13-39

Murray, F. (1994, September). Ways to decrease our oversized health-care bill. Better Nutrition for Today's Living, 56(9), 6. Retrieved December 7, 2008, from ProQuest Health and Medical Complete database. (Document ID: 5797962).

Nakamura, K., Okamura, T., Hayakawa, T., Kanda, H., Okayama, A., & Ueshima, H. (2010). Medical expenditures of men with hypertension and/or a smoking habit: a 10-year follow-up study of National Health Insurance in Shiga, Japan. *Hypertension Research: Official Journal of the Japanese Society of Hypertension*, 33(8), 802-807.

Navarro, F. H. (1988) Age, sex, and psychographics—their impact on health care use among group-insured adults. *1988 Group Health Proceedings, Group Health Institute '88, Group Health Association of America*. Chicago, IL, June, pp. 303-318.

Navarro, F. H. (1999). Linking healthcare attitudes and behaviors to medical care demand among seniors, in Prospective Medicine: the Tools, the Data, the Interventions, and the Outcomes, Proceedings of the Thirty-fifth Annual Meeting of the Society of Prospective Medicine, pp. 210-217

Navarro, F. H. (2011). Patterns of Adapting to Health (PATH) Inventory. Available from the author.

Navarro, F. H. (2013, January). Language semantics: word frequency, context, and action semantics. Walden University. Retrieved from https://www.academia.edu/4352546/Language_Semantics_Word_Frequency_Context_and_Action_Semantics

Navarro, F. H. (2015, February). Patterns of Adapting to Health (PATH) Inventory: Cognitive-Behavior-Adaptive Dynamics. Retrieved from https://www.academia.edu/12873195/Patterns_of_Adapting_to_Health_PATH_Inventory_Cognitive-Adaptive-Behavioral_Dynamics

Nightengale, B. S., Crumly, J. M., Liao, J., Lawrence, B. J., & Jacobs, E. W. (1998). Economic outcomes of antipsychotic agents in a Medicaid population: traditional agents vs. risperidone. *Psychopharmacology Bulletin*, 34(3), 373-82. Retrieved from http://search.proquest.com/docview/212438643?accountid=14872

Orszag, P. R., (2008, January). Growth in health care costs. Washington, D.C.: Congressional Budget Office. Retrieved December 29, 2008 from http://www.cbo.gov/ftpdocs/89xx/doc8948/01-31-HealthTestimony.pdf

Palsdottir, A. (2008). Information Behaviour, Health Self-Efficacy Beliefs and Health Behaviour in Icelanders' Everyday Life. *Information Research: An International Electronic Journal*, 13(1).

Pedhazur, E. J. (1982). Multiple regression in behavioral research (2nd Ed). New York, NY: Holt, Rinehart and Winston.

PSPP (2007, June 29). Version 3. [Computer software] GNU.org. Retrieved from http://pspp.awardspace.com/

Rauscher, G. H., Johnson, T. P., Cho, Y. I., & Walk, J. A. (2008). Accuracy of self-reported cancer-screening histories: a meta-analysis. *Cancer Epidemiology Biomarkers & Prevention*, 17 (4), 748-757.

Rovniak, L. S., Sallis, J. F., Saelens, B. E., Frank, L. D., Marshall, S. J., Norman, G. J., et al. (2010). Adults' physical activity patterns across life domains: Cluster analysis with replication. *Health Psychology*, 29(5), 496-505.

Rupper, R. W., Konrad, T. R., Garrett, J. M., Miller, W., & Blazer, D. G. (2004). Self-reported delay in seeking care has poor validity for predicting adverse outcomes. *Journal of the American Geriatrics Society*, 52(12), 2104-2109.

Schneider, S., Huy, C., Schuessler, M., Diehi, K., & Schwarz, S. (2009). Optimising lifestyle interventions: identification of health behaviour patterns by cluster analysis in a German 50+ survey. *European Journal of Public Health*, 19(3), 271-277.

Stewart, S. (2004, February). Do out-of-pocket health expenditures rise with age among older Americans?. *Gerontologist*, 44(1), 48-57.

Tabachnick, B. G. & Fidell, L. S. (2007). Using multivariate statistics. Boston, MA: Allyn and Bacon.

Thom, D. H., Hall, M. A., & Pawlson, L. G. (2004). Measuring patients' trust in physicians when assessing quality of care. *Health Affairs*, 23(4), 124-132.

Thorpe, K. E., Ogden, L. L., & Galactionova, K. (2010). Chronic conditions account for rise in Medicare spending from 1987 to 2006. *Health Affairs*, 29(4), 718-724.

Tsai, A. G., Williamson, D. F. and Glick, H. A. (2011). Direct medical cost of overweight and obesity in the USA: a quantitative systematic review. *Obesity Reviews*, 12: 50–61. doi: 10.1111/j.1467-789X.2009.00708.x

U.S. Department of Health and Human Services, Centers for Medicare and Medicaid [CMS] (2011, January). National Health Expenditure Projections 2010-2020. Retrieved from https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/downloads/proj2010.pdf

U.S. Department of Commerce, US Census Bureau [US Census] (2012, June 27). The 2012 Statistical Abstract: The National Data Book: Table 137. Health Consumption Expenditures--Per Capita Spending by Type of Expenditure and Source of Funds: 1990 to 2009. Retrieved from http://www.census.gov/compendia/statab/2012/tables/12s0137.xls

U.S. Department of Health and Human Services, Centers for Medicare and Medicaid [CMS] (n.d.). National Health Expenditure Projections 2010-2020. Retrieved from https://www.cms.gov/Research-Statistics-Data-and-Systems/

Statistics-Trends-and-Reports/NationalHealthExpendData/downloads/proj2010.pdf

U.S. Department of Health and Human Services, Centers for Medicare and Medicaid [CMS] (2011, January). National Health Expenditure Projections 2010-2020. Retrieved from https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/downloads/proj2010.pdf

United States Department of Health and Human Services, Centers for Disease Control and Prevention, Center for Health Statistics [CHS] (2012, May 9). Health, United States, 2011: With Special Feature on Socioeconomic Status and Health. Hyattsville, MD., Table 133, p 384. Retrieved from http://www.cdc.gov/nchs/data/hus/hus11.pdf

van Elk, M., van Schie, H. T., & Bekkering, H. (2009). Action semantic knowledge about objects is supported by functional motor activation. *Journal of Experimental Psychology: Human Perception and Performance*, 35(4), 1118-1128. doi:10.1037/a0015024

Verger, P., Lions, C., & Ventelou, B. (2009). Is depression associated with health risk-related behaviour clusters in adults? *European Journal of Public Health*, 19(6), 618-624.

White, R. R., Lenhart, G., Singhal, P. K., Insinga, R. P., Itzler, R. F., Pellissier, J. M., & Segraves, A. W. (2009). Incremental 1-Year medical resource utilization and costs for patients with herpes zoster from a set of US Health Plans. *Pharmacoeconomics*, 27(9), 781-792.

Wolkowitz, O. M., Epel, E. S., Reus, V. I., & Mellon, S. H. (2010). Depression gets old fast: do stress and depression accelerate cell aging? *Depression & Anxiety* (1091-4269), 27(4), 327-338. doi:10.1002/da.20686

Xuemei, L. (2004). Estimates and patterns of direct health care expenditures among individuals with back pain in the United States. *Spine*, 29(1), 79-86.

Zabinski, M. F., Norman, G. J., Sallis, J. F., Calfas, K. J., & Patrick, K. (2007). Patterns of sedentary behavior among adolescents. *Health Psychology*, 26(1), 113-120.

Zivin, K., Ratliff, S., Heisler, M. M., Langa, K. M., & Piette, J. D. (2010). Factors influencing cost-related nonadherence to medication in older adults: a conceptually based approach. *Value in Health* (Wiley-Blackwell), 13(4), 338-345. doi:10.1111/j.1524-4733.2009.00679.x