Qual Life Res (2013) 22:521–529
DOI 10.1007/s11136-012-0168-9

BRIEF COMMUNICATION

Psychometric assessment of the patient activation measure short form (PAM-13) in rural settings

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Accepted: 20 March 2012 / Published online: 31 March 2012

Abstract
Purpose The patient activation measure short form (PAM-13) assesses patients' self-reported health management skills, knowledge, confidence, and motivation. We used item response theory to evaluate the psychometric properties of the PAM-13 utilized in rural settings.
Methods A Rasch partial credit model analysis was conducted on the PAM-13 instrument using a sample of 812 rural patients recruited by providers and our research staff. Specially, we examined dimensionality, item fit, and quality of measures, category response curves, and item differential functioning. Convergent and divergent validities were also examined.
Findings The PAM-13 instrument has excellent convergent and divergent validities. It is fairly unidimensional, and all items fit the Rasch model well. It has relatively high person and item reliability indices. Majority of the items were free of item differential functioning. There were, however, some issues with ceiling effects. Additionally, there was a lack of responses for category one across all items.
Conclusions Patient activation measure short form (PAM-13) performs well in some areas, but not all. In general, more items need to be added to cover the upper end of the trait. The four response categories of PAM-13 should be collapsed into three.

Keywords Patient activation measure · Electronic medical record · Psychometric · Rasch · Health care management · Quality of life

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Introduction

Effective self-management requires knowledge and plays a pivotal role in achieving successful treatment outcomes. In order to improve the quality of care, providers must identify patients lacking self-management skills and intervene appropriately. To identify these patients, practitioners need a valid and reliable tool. The patient activation measure short form (PAM-13) [1] consists of 13 items measuring patients' self-reported knowledge, motivation, and skills for health management (Appendix 1). It was developed using a Rasch model [2] and has been validated in the US general population.

Rural communities are often less studied than urban regions [3, 4]. Rural patients are more isolated than the general population [3–5] and could exhibit different health behaviors. For instance, rural patients have been reported to be hospitalized more often than non-rural patients [6] and face more barriers to access, including increased travel and limited specialty care [3, 4]. Rural areas have a larger elderly population [7, 8], less education [9], and increased chronic health conditions [10–12]. The goal of this study was to examine PAM-13 for validity–dimensionality, DIF, convergent, and discriminant validities in the rural population.

Methods

Participants/data collection

We performed a demonstration project on integrating a personal health record with an electronic medical record (EMR), called the unified health resource (UHR). Four primary care clinics from the Intermountain West were recruited and they served rural communities ranging from 8,000 to 22,500 individuals. Two clinics used the UHR, while the other two used an EMR. We conducted a telephone survey on 812 patients from all 4 clinics using PAM-13, consumer assessment of healthcare providers and systems (CAHPS®) [13], and a self-management (SM) survey developed by our team. SM requires subject-based knowledge and motivation. The purpose of the SM survey was to measure patients' knowledge and behavior in managing their personal health and to validate the PAM-13. The SM survey contains a total of 7 items (Appendix 3).

Statistical analysis

A one-parameter Item Response Theory model, known as the Rasch model [2, 14], was utilized to evaluate PAM-13. Rasch can correct some of the traditional assumptions (e.g., interval scale) made by the classical test theory models and may potentially create equal interval scores, overcoming methodological challenges to provide objective measurement.

We analyzed correlations between PAM and the SM subscales to investigate validity. The SM subscales consist of self-management knowledge (SMK) and self-management willingness to change (SMW). We hypothesized that patients with high PAM scores should have high SM scores.

We applied the Rasch partial credit model (PCM) [15–18] to our sample to examine model-data fit using WINSTEPS [19]. The Rasch PCM was chosen because the PAM items had more than 2 response options and showed different patterns of usage. There are various statistical indices within the Rasch framework that can be used to check whether the data fit the model. In this study, we examined these indices: unidimensionality, item difficulty, quality measures, category response functions, and differential item functioning (DIF).

Category response function assesses whether the response categories define a distinct position on the scale. A functional scale should not have disordered thresholds, <10 responses per categories, and outfit MNSQ > 2 [14].

DIF occurs when the difficulty levels of items vary systematically based on sample characteristics. It provides

Table 1 Patient demographics

Gender	
Male	312 (38.4 %)
Female	500 (61.6 %)
Clinics	
UHR	405 (49.9 %)
Non-UHR	407 (50.1 %)
Disease	
Chronic	638 (78.6 %)
Non-chronic	174 (21.4 %)
Education	
High school or under	241 (37.1 %)
At least some college	570 (62.8 %)
Would not say	1 (.1 %)
Age	
Under 45	289 (35.6 %)
45 or over	523 (64.4 %)
Race	
White	52 (92.6 %)
Asian	1 (.1 %)
Nat Hawaiian/Pac Is	3 (.4 %)
Other	37 (4.6 %)
Multiple race	14 (1.7 %)
Would not say	4 (.5 %)
Missing	1 (.1 %)
Hispanic/Latino origin	
Hispanic/Latino	37 (4.6 %)
Non-Hispanic/Latino	773 (95.2 %)
Would not say	2 (.2 %)

Table 2 Correlations between PAM, CAHPS, and SM subscales

	PAM	CAHPS_care	CAHPS_doc	CAHPS_staff	SMW	SMK
PAM	1	.007	.125	.024	.406	.388
CAHPS_care		1	.286	.261	.045	.076
CAHPS_doc			1	.344	.051	.199
CAHPS_staff				1	.038	.054
SMW					1	.387
SMK						1

Table 3 Item category function of PAM-13 (all 4 categories included)

Item	Category label	Observed count	Average measure	Outfit MNSQ	Threshold
1	1[a,b,c]	8	1.52	2.71	None
	2[c]	11	−.11	.76	−.14
	3	416	1.19	.91	−2.62
	4	371	3.71	.85	2.76
2	1[a,c]	2	1.67	1.51	None
	2[c]	12	.91	1.26	−1.34
	3	482	1.33	.98	−2.31
	4	315	3.94	.86	3.65
3	1[a]	4	.14	1.61	None
	2	26	.50	.81	−1.90
	3	543	1.59	.96	−2.09
	4	223	4.43	.78	3.99
4	1[a,c]	3	1.27	1.70	None
	2[c]	21	.36	1.11	−1.65
	3	469	1.34	.96	−1.90
	4	290	4.08	.79	3.56
5	1[a]	2	.40	1.37	None
	2	39	.54	1.04	−2.69
	3	521	1.59	.95	−1.35
	4	248	4.24	.91	4.04
6	1[a]	4	−.96	.67	None
	2	24	.58	1.00	−1.57
	3	482	1.38	.89	1.88
	4	302	4.06	.84	3.45
7	1[a]	1	−1.10	.56	None
	2	17	−.22	.76	−2.24
	3	501	1.38	.62	−1.85
	4	277	4.31	.66	4.09
8	1[a]	6	.30	1.41	None
	2	43	.64	.99	−2.12
	3	532	1.58	.75	−1.72
	4	214	4.56	.73	3.84
9	1[a]	3	.13	1.29	None
	2	52	.34	.83	−2.93
	3	544	1.74	.73	−1.42
	4	182	4.83	.72	4.35
10	1[a]	6	.16	1.62	None
	2	55	.62	.95	−2.54
	3	549	1.83	1.08	−1.63
	4	175	4.60	.98	4.17
11	1[a]	8	−.03	1.49	None
	2	82	.82	1.10	−2.73
	3	517	1.81	.84	−1.26
	4	174	4.78	.86	3.99
12	1[a]	7	.65	1.65	None
	2	140	.98	1.29	−3.65
	3	527	2.19	.99	−.90
	4	120	4.96	1.08	4.54
13	1[a,b]	4	.76	2.01	None
	2	108	1.09	1.27	−3.66
	3	554	2.05	1.11	−.94
	4	140	4.66	1.23	4.60

[a] Observed count is <10

[b] Outfit MNSQ is >2.0

[c] Disordered threshold

one source of evidence of item bias and answers the question whether an item functions similarly across different subgroups of patients [15, 20–22]. In this study, we were particularly interested in whether patients with chronic diseases respond to individual items in the same way as patients without chronic diseases, given that they all have the same overall activation measure. We are also interested in assessing age DIF (i.e., age 45 or older vs. under 45 years old) and gender DIF (i.e., female vs. male). A *t*-statistics of $p > .05$ would indicate that the item shows no evidence of DIF.

Dimensionality analyses address whether multiple constructs are needed to explain all of the variance in the data. It is evaluated using principal component analysis of residuals after the initial Rasch factor is removed [14]. These criteria were used to assess unidimensionality: (1) the variance explained by the first contrast in the residuals is <10 % and (2) the eigenvalue of the first contrast is <3.0 [19].

The person separation index (PSI), item separation index (ISI), and item fit are indicators of quality of measures. Item fit indicates whether a set of items fit the Rasch model and it can be evaluated using the outfit mean square (MNSQ) statistics. Outfit MNSQ close to 1 is considered good fit and >2 is considered misfit [14] and hence should be excluded. The PSI refers to the reproducibility of the relative measure location of the persons, where the ISI refers to the reproducibility of the relative measure location of the items [19]. A separation index of 2 or higher (corresponding to a reliability of .80 or higher) is considered reliable.

Results

Descriptive statistics

The sample is composed of primarily Caucasians, with 78 % having chronic disease. Half were from the UHR

clinics. Over 60 % were women; 65 % were 45 years or older; and 63 % had at least some college (Table 1).

Among the 4 response categories in PAM (i.e., strongly disagree, disagree, agree, strongly agree), not a single category was endorsed by over 70 % of people. The "strongly disagree" category was chosen by <1 %, indicating high activation levels. Less than 2 % of responses were missing across all items; however, Rasch measurement investigates responses at the item level and supports use of incomplete data [15].

Table 4 Item category function of PAM-13 (after collapsing categories 1 and 2)

Item	Category label	Observed count	Average measure	Outfit MNSQ	Threshold
1	1/2	19	−.50	1.60	None
	3	416	−.01	.93	−2.52
	4	371	2.62	.85	2.52
2	1/2	14	−.31	1.35	None
	3	482	.16	.98	−3.01
	4	315	2.85	.88	3.01
3	1/2	30	−.78	.90	None
	3	543	.43	.95	−3.06
	4	223	3.33	.80	3.06
4	1/2	24	−.66	1.28	None
	3	469	.15	.97	−2.76
	4	290	3.01	.77	2.76
5	1/2	51	−.70	1.08	None
	3	521	.42	.94	−2.75
	4	248	3.15	.93	2.75
6	1/2	28	−.90	.99	None
	3	482	.20	.89	−2.68
	4	302	2.99	.83	2.68
7	1/2	18	−1.75	.81	None
	3	501	.21	.62	−3.03
	4	277	3.23	.64	3.03
8	1/2	49	−.65	1.05	None
	3	532	.41	.75	−2.79
	4	214	3.49	.70	2.79
9	1/2	55	−.98	.88	None
	3	544	.59	.73	−2.93
	4	182	3.76	.70	2.93
10	1/2	61	−.64	1.01	None
	3	549	.67	1.08	−2.92
	4	175	3.51	.97	2.92
11	1/2	90	−.52	1.11	None
	3	517	.67	.83	−2.65
	4	174	3.70	.83	2.65
12	1/2	147	−.26	1.32	None
	3	527	1.06	.97	−2.75
	4	120	3.87	1.08	2.75
13	1/2	112	−.13	1.33	None
	3	554	.91	1.14	−2.81
	4	140	3.59	1.20	2.81

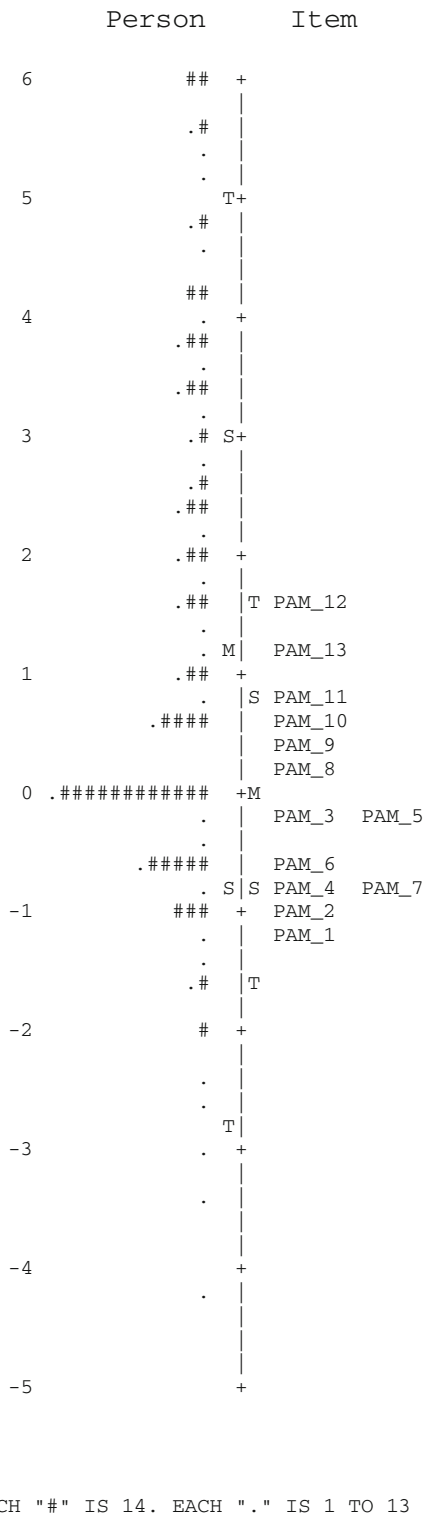

Fig. 1 Person–item map for the entire sample (in logit *scale*)

In addition to the PAM survey, the CAHPS and the SM surveys (Appendices 1, 2 and 3) were used to examine divergent and convergent validities. All items were first calibrated using a Rasch model, then scored (Table 2). The correlations between PAM and CAHPS subscales were small (r range = .007–.125), demonstrating divergent validity. The correlations between PAM and SM subscales were moderately high ($r \sim .4$), demonstrating convergent validity.

Response category function

Table 3 displays the observed count per category, outfit MNSQ, and thresholds for each item. Three items showed disordered thresholds; two had outfit MNSQ >2; all had observed count of <10 in category 1, implying that the 4 categories should be collapsed into 3 to reduce patients' cognitive burden. Hence, we collapsed categories 1 and 2 into a single category, which did not reveal further

Table 5 Item differential functioning—Chronic diseases

Person class	Dif measure	Dif SE	Person class	Dif measure	Dif SE	Dif contrast	Joint SE	Welch			Item number	Item name
								t	*df*	Prob.		
0	−1.36	.20	1	−1.11	.10	−.25	.22	−1.15	351	.2518	1	PAM_1
0	−1.20	.20	1	−1.05	.11	−.15	.23	−.65	360	.5192	2	PAM_2
0	−.23	.21	1	−.20	.11	−.03	.23	−.14	334	.8916	3	PAM_3
0	−.54	.21	1	−.75	.10	.22	.23	.92	303	.3569	4	PAM_4
0	−.28	.20	1	−.10	.10	−.18	.22	−.80	357	.4261	5	PAM_5
0	−.30	.19	1	−.73	.10	.43	.22	1.97	360	.0491	6[a]	PAM_6
0	−.94	.21	1	−.72	.11	−.23	.23	−.97	344	.3316	7	PAM_7
0	.34	.20	1	.06	.10	.28	.22	1.25	330	.2127	8	PAM_8
0	.58	.20	1	.37	.10	.22	.23	.94	314	.3490	9	PAM_9
0	.46	.20	1	.53	.10	−.07	.23	−.31	321	.7571	10	PAM_10
0	.50	.20	1	.85	.10	−.35	.22	−1.60	311	.1102	11	PAM_11
0	1.27	.18	1	1.70	.09	−.43	.21	−2.10	344	.0366	12[a]	PAM_12
0	1.67	.18	1	1.11	.10	.56	.20	2.76	366	.0061	13[a]	PAM_13

For person class: 0 = do not have chronic diseases and 1 = have chronic disease(s)

[a] Item with significant DIF

Table 6 Item differential functioning—gender

Person class	Dif measure	Dif SE	Person class	Dif measure	Dif SE	Dif contrast	Joint SE	Welch			Item number	Item name
								t	*df*	Prob.		
0	−1.16	.14	1	−1.16	.11	.00	.18	.00	698	1.000	1	PAM_1
0	−1.08	.15	1	−1.08	.12	.00	.19	.00	699	1.000	2	PAM_2
0	−.20	.15	1	−.20	.12	.00	.20	.00	681	1.000	3	PAM_3
0	−.66	.15	1	−.75	.12	.08	.19	.44	673	.6576	4	PAM_4
0	.12	.14	1	−.30	.12	.42	.18	2.29	696	.0226	5[a]	PAM_5
0	−.63	.14	1	−.63	.12	.00	.18	.00	700	1.000	6	PAM_6
0	−.60	.15	1	−.87	.12	.28	.20	1.41	681	.1576	7	PAM_7
0	.07	.15	1	.14	.12	−.07	.19	−.39	683	.6994	8	PAM_8
0	.64	.15	1	.28	.12	.36	.19	1.89	668	.0592	9	PAM_9
0	.41	.15	1	.60	.12	−.19	.19	−.98	670	.3291	10	PAM_10
0	.62	.14	1	.88	.11	−.26	.18	−1.47	665	.1417	11	PAM_11
0	1.73	.13	1	1.53	.11	.20	.17	1.17	678	.2411	12	PAM_12
0	.77	.14	1	1.50	.11	−.73	.18	−4.10	676	.0000	13[a]	PAM_13

For person class: 0 = male, 1 = female

[a] Item with significant DIF

Table 7 Item differential functioning—age

Person class	Dif measure	Dif SE	Person class	Dif measure	Dif SE	Dif contrast	Joint SE	Welch			Item number	Item name
								t	*df*	Prob.		
0	−1.52	.22	1	−1.09	.10	−.43	.24	−1.82	263	.0702	1	PAM_1
0	−1.27	.22	1	−1.04	.10	−.23	.24	−.94	274	.3492	2	PAM_2
0	−.15	.23	1	−.20	.11	.05	.25	.20	255	.8447	3	PAM_3
0	−.76	.23	1	−.71	.10	−.05	.25	−.20	250	.8426	4	PAM_4
0	−.41	.22	1	−.08	.10	−.33	.24	−1.40	268	.1639	5	PAM_5
0	−.48	.21	1	−.67	.10	.18	.24	.78	271	.4363	6	PAM_6
0	−.57	.23	1	−.81	.10	.23	.25	.94	260	.3503	7	PAM_7
0	.08	.22	1	.12	.10	−.03	.24	−.13	252	.8934	8	PAM_8
0	.41	.23	1	.41	.10	.00	.25	.00	250	1.000	9	PAM_9
0	1.00	.22	1	.43	.10	.57	.24	2.32	247	.0214	10[a]	PAM_10
0	.36	.22	1	.86	.09	−.50	.24	−2.10	232	.0370	11[a]	PAM_11
0	1.44	.21	1	1.64	.09	−.20	.23	−.88	248	.3824	12	PAM_12
0	1.83	.20	1	1.11	.09	.72	.22	3.23	272	.0014	13[a]	PAM_13

For person class: 0 = under 45 years old and 1 = 45 years or older

[a] Item with significant DIF

disordering in reanalysis (see Table 4). Subsequent Rasch analysis was based on the 3 category options.

Dimensionality

Rasch dimensionality analysis was conducted on the 13 items. Results indicated that the variance attributable to the first contrast was 6.3 % with a strength of 1.5 eigenvalue units, implying unidimensionality. Multidimensional models were not tested as our sample size was quite small, and we were mainly interested to see whether our results replicate the developer's using the same model.

Item difficulty

Figure 1 displays the spread of all items and patients along a standardized linear logit scale. The central vertical dash line is a ruler separating items on the right and patients on the left. The top of the ruler corresponds to high activation levels, whereas the bottom corresponds to low activation. The map reveals that the items target the lower level of patients' activation very well. However, the majority of the sample landed at the upper end that lacked coverage, reflecting a ceiling effect.

Quality of measures

The PSI was 2.36, corresponding to Cronbach's reliability index of .85, while ISI was 9.15, equivalent to a reliability of .99. The outfit MNSQ ranged from .67 to 1.24, reflecting excellent item fit (Fig. 2) and construct validity.

Differential item functioning

We performed uniform DIF testing and considered items with a t-statistics of $p < .05$ as showing statistical evidence of DIF. Results indicated that 3 items showed chronic disease DIF; 2 showed gender DIF; and 3 showed age DIF (see Tables 5, 6 and 7, respectively). Non-uniform DIF testing was not conducted due to the small sample size [20].

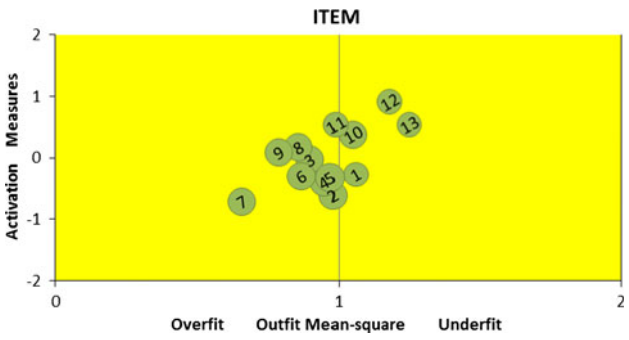

Fig. 2 PAM-13 item fit

Discussion

This study utilized a Rasch model to validate the PAM-13 in rural populations. Results indicated that PAM-13 performs well in some areas, but not all. The items had excellent fit statistics and largely confirmed to undimensionality. The person and item reliability indices were high, suggesting that person and item orderings were both replicable. The PAM-13 also demonstrated high convergent and divergent validities. However, the item hierarchy revealed considerable ceiling effects, posing several potential problems. This should be addressed in future tool refinement to better capture the responses of those with high activation, and track improvements. Items that showed flat category probability curves or disordered thresholds imply that some response categories were unnecessary. Only PAM_#13 showed consistent evidence of DIF across chronic disease, gender, and age, indicating a need for item refinement.

In summary, the PAM-13 showed ceiling effects and should be interpreted with caution when examining change over time. For future scale revision, this study suggests two areas for consideration: (1) collapse categories 1 and 2 for all items to improve parameter estimation and (2) add some high-end items to the scale to cover the upper end of the trait.

Acknowledgments This investigation was supported by the Agency for Healthcare Research and Quality research grant number R18-HS-017308.

Appendix 1

See Table 8.

Table 8 PAM questions

PAM_1	When all is said and done, I am the person who is responsible for taking care of my health	Disagree strongly	Disagree	Agree	Agree strongly	N/A
PAM_2	Taking an active role in my own health care is the most important thing that affects my health	Disagree strongly	Disagree	Agree	Agree strongly	N/A
PAM_3	I am confident I can help prevent or reduce problems associated with my health	Disagree strongly	Disagree	Agree	Agree strongly	N/A
PAM_4	I know what each of my prescribed medications do	Disagree strongly	Disagree	Agree	Agree strongly	N/A
PAM_5	I am confident that I can tell whether I need to go to the doctor or whether I can take care of a health problem myself	Disagree strongly	Disagree	Agree	Agree strongly	N/A
PAM_6	I am confident that I can tell a doctor concerns I have even when he or she does not ask	Disagree strongly	Disagree	Agree	Agree strongly	N/A
PAM_7	I am confident that I can follow through on medical treatments I may need to do at home	Disagree strongly	Disagree	Agree	Agree strongly	N/A
PAM_8	I understand my health problems and what causes them	Disagree strongly	Disagree	Agree	Agree strongly	N/A
PAM_9	I know what treatments are available for my health problems	Disagree strongly	Disagree	Agree	Agree strongly	N/A
PAM_10	I have been able to maintain (keep up with) lifestyle changes, like eating right or exercising	Disagree strongly	Disagree	Agree	Agree strongly	N/A
PAM_11	I know how to prevent problems with my health	Disagree strongly	Disagree	Agree	Agree strongly	N/A
PAM_12	I am confident I can figure out solutions when new problems arise with my health	Disagree strongly	Disagree	Agree	Agree strongly	N/A
PAM_13	I am confident that I can maintain lifestyle changes, like eating right and exercising, even during times of stress	Disagree strongly	Disagree	Agree	Agree strongly	N/A

Appendix 2

See Table 9.

Table 9 CAHPS questions

CAHPS_care						
1. In the last 12 months, when you phoned this provider's office to get an appointment for care you needed right away, how often did you get an appointment as soon as you thought you needed?	Never	Almost never	Sometimes	Usually	Almost always	Always
2. In the last 12 months, when you made an appointment for a check-up or routine care with this provider, how often did you get an appointment as soon as you thought you needed?	Never	Almost never	Sometimes	Usually	Almost always	Always
3. In the last 12 months, when you phoned this provider's office during regular office hours, how often did you get an answer to your medical question that same day?	Never	Almost never	Sometimes	Usually	Almost always	Always
4. In the last 12 months, when you phoned this provider's office after regular office hours, how often did you get an answer to your medical question as soon as you needed?	Never	Almost never	Sometimes	Usually	Almost always	Always
5. In the last 12 months, how often did you see this provider within 15 min of your appointment time?	Never	Almost never	Sometimes	Usually	Almost always	Always
CAHPS_doc						
1. In the last 12 months, how often did this provider explain things in a way that was easy to understand?	Never	Almost never	Sometimes	Usually	Almost always	Always
2. In the last 12 months, how often did this provider listen carefully to you?	Never	Almost never	Sometimes	Usually	Almost always	Always
3. In the last 12 months, how often did this provider give you easy to understand instructions about taking care of these health problems or concerns?	Never	Almost never	Sometimes	Usually	Almost always	Always
4. In the last 12 months, how often did this provider seem to know the important information about your medical history?	Never	Almost Never	Sometimes	Usually	Almost always	Always
5. In the last 12 months, how often did this provider show respect for what you had to say?	Never	Almost never	Sometimes	Usually	Almost always	Always
6. In the last 12 months, how often did this provider spend enough time with you?	Never	Almost never	Sometimes	Usually	Almost always	Always
CAHPS_staff						
1. In the last 12 months, how often were clerks and receptionists at this provider's office as helpful as you thought they should be?	Never	Almost never	Sometimes	Usually	Almost always	Always
2. In the last 12 months, how often did clerks and receptionists at this provider's office treat you with courtesy and respect?	Never	Almost never	Sometimes	Usually	Almost always	Always

Appendix 3

See Table 10.

Table 10 SM questions

SMW					
1. I am willing to choose foods that help me keep a balance diet	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
2. I am willing to actively monitor my personal health conditions	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
3. I think it is important for me to stick to an exercise program	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
4. I am willing to exercise regularly	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
SMK					
1. How do you rate your understanding of the role of diet in preventing and treating various health problems?	Poor	Fair	Good	Very good	Excellent
2. How do you rate your understanding of how to monitor your personal health conditions?	Poor	Fair	Good	Very good	Excellent
3. How do you rate your understanding of the role of exercise in maintaining your health?	Poor	Fair	Good	Very good	Excellent

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