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## PROMIS®-29 v2.0 Profile Physical and Mental Health Summary Scores

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### Abstract

**Purpose**—The PROMIS-29 v2.0 profile assesses pain intensity using a single 0–10 numeric rating item and seven health domains (physical function, fatigue, pain interference, depressive symptoms, anxiety, ability to participate in social roles and activities, and sleep disturbance) using four items per domain. This paper describes the development of physical and mental health summary scores for the PROMIS-29 v2.0.

**Method**—We conducted factor analyses of PROMIS-29 scales on data collected from two internet panels ( $n = 3,000$  and  $2,000$ ).

**Results**—Confirmatory factor analyses provided support for a physical health factor defined by physical function, pain (interference and intensity), and ability to participate in social roles and activities, and a mental health factor defined primarily by emotional distress (anxiety and depressive symptoms). Reliabilities for these two summary scores were 0.98 (physical health) and 0.97 (mental health). Correlations of the PROMIS-29 v2.0 physical and mental health summary scores with chronic conditions and other health-related quality of life measures were consistent with a-priori hypotheses.

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#### Conflict of Interest

The authors declare that they have no conflict of interest.

**Conclusions**—This study develops and provides preliminary evidence supporting the reliability and validity of PROMIS-29 v2.0 physical and mental health summary scores that can be used in future studies to assess impacts of health care interventions and track changes in health over time. Further evaluation of these and alternative summary measures is recommended.

### Keywords

physical health; mental health; patient-reported; PROMIS®; PROMIS®-29 profile

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### Introduction

The Patient-Reported Outcomes Measurement Information System (PROMIS®) is a National Institutes of Health initiative to develop state-of-the-science self-report measures to assess functioning and well-being in physical, mental and social domains of health [1]. PROMIS measures are potentially useful to screen for disability, identify health care disparities, enhance communication between patients and clinicians, and improve population health. Moreover, self-reported health is predictive of health care utilization [2] and subsequent mortality [3–4].

PROMIS includes item banks that can be administered using computer-adaptive testing [5], short forms for individual domains [6], and profiles that yield information about multiple domains for use in clinical trials, observational studies, and clinical practice [7–9]. The PROMIS-29 v2.0 profile measure assesses pain intensity using a single 0–10 numeric rating item and seven health domains (physical function, fatigue, pain interference, depressive symptoms, anxiety, ability to participate in social roles and activities, and sleep disturbance) using four items for each domain. The PROMIS-29 v2.0 profile measure is analogous to the most widely used profile measure to date, the SF-36. But the PROMIS-29 v2.0 profile items were selected from PROMIS item banks [10–15] calibrated using item response theory (IRT) analyses and all items in a domain are scored on the same underlying metric.

While profile measures yield a wealth of information, higher-order summary measures are also useful [16]. Factor analyses of scale scores for the SF-36 health survey, provided strong support for two underlying factors with physical health defined primarily by measures of physical functioning, pain, and role limitations due to physical health problems, and by mental health reflected primarily by measures of emotional well-being and role limitations caused by emotional problems [17–18]. General health perceptions, vitality, and social functioning represent both physical and mental health about equally.

This paper presents the development of physical and mental health summary scores for the PROMIS-29 v2.0. Based on previous work [17–20], we hypothesized that physical health would be primarily represented by physical function and pain. In addition, we hypothesized that mental health would be indicated primarily by depressive symptoms, anxiety and sleep disturbance, and to some extent by ability to participate in social roles and activities, and pain. We expected fatigue to be indicative of both physical and mental health.

## Method

### Participants

**Sample 1**—We administered by internet the PROMIS-29 v2.0 profile measures to a sample of 3,000 Opinions 4 Good (Op4G) panel members [21]. Op4G maintains a US national sample, and participants are required to update demographic information regularly. The sample was 51% female, 60% non-Hispanic White, 17% Hispanic, 14% non-Hispanic Black, 9% Asian, and 1% other race/ethnicity. The average age was 46 and ranged from 18–88 years old. Twenty-seven percent had a college degree, 28% had some college, 31% were high school graduates, and 14% reported less than a high school education. Fifty-seven percent were married or living with a partner, 30% were never married, 10% separated or divorced, and 3% widowed.

**Sample 2**—Toluna/Greenfield internet panel members [22] were sent e-mail invitations to obtain responses from 2000 participants. Panelists were given a link that took them to a secure Web site where the survey was administered, after they provided consent. The sample was 50% female, 81% non-Hispanic White, 6% Hispanic, 7% non-Hispanic Black, 4% Asian, and 2% other race/ethnicity. The average age was 52 and the range was 18–93 years old. Thirty percent had a college degree, 42% had some college, 25% were high school graduates, and 3% reported less than a high school education. Fifty-six percent were married or living with a partner, 20% were never married, 14% separated or divorced, and 10% widowed.

### Measures

Sample 1 was administered the PROMIS-29 v2.0 profile that assesses social health using the Ability to Participate in Social Roles and Activities scale (Short Form 4a) while Sample 2 was administered the PROMIS-29 v1.0 profile that uses the Satisfaction with Participation in Social Roles scale (Short form 4a). PROMIS-29 scales are scored using a T-score metric via *Assessment Center* (see [www.assessmentcenter.net](http://www.assessmentcenter.net) and <https://www.youtube.com/watch?v=KM2FqYoS--A>). The pain intensity item asks *In the last 7 days, how would you rate your pain on average?* The response scale is 0 (no pain) to 10 (worst imaginable pain). While this 0–10 item has been collapsed to 5 categories (0 = 1; 1–3 = 2; 4–6 = 3; 7–9 = 4; 10 = 5) in some prior PROMIS studies [18], we preserved the 11 categories of information.

Both samples provided self-reports of demographic characteristics (age and gender) and chronic conditions: hypertension, angina, coronary artery disease, heart failure, heart attack, stroke, liver disease, kidney disease, arthritis, migraines, asthma, chronic lung disease, diabetes, cancer, depression, anxiety, alcohol or drug problem, sleep disorder, HIV/AIDS, spinal cord injury, and multiple sclerosis (Sample 2 did not include spinal cord injury). Sample 1 included the HUI-3 [23] and PROMIS global health items [24]. The EQ-5D-3L was estimated from the PROMIS global health items [25]. Sample 2 included the SF-36 v2 [26] and we estimated the SF-6D from it [27].

## Statistical Analyses

We estimate internal consistency reliability [28] and item response theory estimates of marginal reliability for the 7 PROMIS-29 v2.0 multi-item scales. Marginal (empirical) reliability was estimated by calculating the ratio of the average of the squared standard errors of observed expected a-posterior (EAP) scores over the observed EAP score variance and subtracting that ratio from one.

Because the underlying structure of the PROMIS-29 scales was unknown, we performed exploratory factor analyses. We examined multiple number of factor criteria (Guttman's weakest lower bound, scree test, Tucker and Lewis reliability coefficients), followed by Promax factor rotation [29–30].

Then, we conducted confirmatory factor analyses. To minimize local dependence among variables, we created a pain composite by averaging z-scores for the pain intensity item and pain interference scale, and we created an emotional distress composite by averaging z-scores for the depressive symptoms and anxiety scales. We fit a correlated two-factor model (physical and mental health) using maximum likelihood estimation. The practical fit of the model was evaluated using the comparative fit index (CFI) and the Root Mean Square Error of Approximation (RMSEA). Good model fit was defined by a CFI > 0.95 and RMSEA < 0.06 [31].

We estimated associations of the PROMIS-29 v2.0 physical and mental health summary scores with the other measures of health-related quality of life, number of chronic conditions, and demographic characteristics in the two samples. The EQ-5D-3L and HUI-3 are preference-based measures designed to summarize health-related quality of life in a single score where 0 is dead and 1 is perfect or optimal health. We hypothesized that the PROMIS-29 v2.0 summary scores would be significantly positively associated with estimates of the EQ-5D-3L and HUI-3 scores and negatively associated with the number of chronic conditions. We hypothesized that these associations would be larger than 0.371, which is equivalent to a 0.80 SD (“large”) effect size. We also hypothesized that the PROMIS-29 v2.0 physical health summary score would be more strongly associated with the SF-36 physical component summary score than with the SF-36 mental health component summary score, and that the PROMIS-29 v2.0 mental health summary score would be more strongly associated with the SF-36 mental health component summary score than with the SF-36 physical health component summary score.

SAS version 9.4 was used for most of the analyses while confirmatory factor analyses were estimated using Mplus Version 7 [32].

## Results

Internal consistency and marginal reliability estimates, respectively, for the PROMIS-29 scales were as follows: physical function (Sample 1: 0.91 and 0.78; Sample 2: 0.93 and 0.73), fatigue (Sample 1: 0.91 and 0.91; Sample 2: 0.95 and 0.91), pain interference (Sample 1: 0.94 and 0.85; Sample 2: 0.86 and 0.83), depressive symptoms (Sample 1: 0.93 and 0.86; Sample 2: 0.95 and 0.80), anxiety (Sample 1: 0.90 and 0.87; Sample 2: 0.91 and 0.80),

ability to participate in social roles and activities/satisfaction with participation in social roles (Sample 1: 0.93 and 0.90; Sample 2: 0.96 and 0.90), and sleep disturbance (Sample 1: 0.77 and 0.82; Sample 2: 0.88 and 0.85). Product-moment correlations among the PROMIS-29 scales and pain intensity item are provided in Appendix Table 1. These correlations ranged from  $-0.40$  (physical function and sleep disturbance) to  $0.82$  (anxiety and depressive symptoms).

Guttman's weakest lower bound in sample 1 indicated a single factor (eigenvalues were 5.08, 0.81, 0.64, 0.49, 0.35, 0.23, 0.22, and 0.18). A scree plot of eigenvalues based on squared multiple correlations as communality estimates (4.71, 0.46, 0.09, 0.05) suggested a single dimension, but Tucker and Lewis's reliability coefficients provided support for two underlying dimensions (0.82 for one factor, 0.95 for two factors, and 0.97 for three factors).

In Sample 2, Guttman's weakest lower bound (eigenvalues of 4.67, 1.14, 0.61, 0.54, 0.34, 0.29, 0.22, and 0.19) and a scree plot of eigenvalues based on squared multiple correlations as communality estimates (4.28, 0.78, 0.20, 0.07) suggested two dimensions. Tucker and Lewis's reliability coefficients indicated the possibility of more than two underlying dimensions (0.66 for one factor, 0.87 for two factors, and 0.94 for three factors).

The two-factor rotated solution for the PROMIS-29 scales showed that the first factor (physical health) was represented by pain interference, physical function, pain intensity, and ability to participate in social roles and activities/satisfaction with participation in social roles and the second factor (mental health) was defined by anxiety and depressive symptoms. Consistent with previous research [19], fatigue and sleep disturbance loaded about equally on both factors (factor loading matrix available upon request).

Based on the results of the exploratory analyses, we evaluated a confirmatory factor analytic model with two factors (physical and mental health) using maximum likelihood estimation in Sample 1. This model fit the data well (Sample 1 and 2, respectively: CFI = 0.99 and 0.99; RMSEA = 0.06 and 0.01, 90% CI 0.05–0.07 and 0.00–0.04) and parameter estimates from Sample 1 are shown in Table 1. We estimated factor scores using the standard regression method with a normal prior. Scores are based on the factor scoring coefficients from Sample 1 and z-scores derived from the PROMIS T-score mean (50) and standard deviation (10). The estimated reliabilities [33] of the PROMIS-29 v2.0 physical health summary scores were 0.93 (Sample 1) and 0.95 (Sample 2). For the PROMIS-29 v2.0 mental health summary score reliability estimates were 0.97 (Sample 1) and 0.98 (Sample 2).

Table 2 provides product-moment correlations of the PROMIS-29 v2.0 physical health and mental health summary scores in Sample 1 with the EQ-5D-3L, HUI-3 preference-based score, the HUI-3 single attribute utilities, number of chronic conditions, gender, and age. The correlations are either similar in magnitude or higher with the PROMIS-29 v2.0 physical health summary score than with the PROMIS-29 v2.0 mental health summary score except for the HUI-3 emotion attribute. Male gender, number of chronic conditions, and age were significantly negatively associated with the PROMIS-29 v2.0 physical and mental health summary scores.

Table 3 shows product-moment correlations of the PROMIS-29 v2.0 physical health and mental health summary scores with the SF-36 scales, SF-36 physical and mental component summary scores, number of chronic conditions, gender, and age in Sample 2. The correlations are either similar in magnitude or higher with the PROMIS-29 v2.0 physical health summary score than with the PROMIS-29 v2.0 mental health summary score except for the SF-36 vitality scale, SF-36 mental health scale, the SF-36 mental component summary score, and age. Note that the PROMIS-29 v2.0 physical health summary score correlated 0.82 with the SF-36 physical component summary score versus 0.54 with the SF-36 mental component summary score, and the PROMIS-29 v2.0 mental health summary score correlated 0.82 with the SF-36 mental component summary score versus 0.38 with the SF-36 physical component summary score. Female gender, number of chronic conditions, and age were significantly negatively associated with the PROMIS-29 v2.0 physical and mental health summary scores.

Appendix Table 2 provides means scores on the PROMIS-29 v2.0 summary scores in Sample 1 by different chronic conditions. Those with a chronic condition scored significantly worse on the PROMIS-29 v2.0 physical health summary score than those without the condition ( $p < 0.0010$ ). Significantly worse PROMIS-29 v2.0 mental health summary scores were reported by those with all of the chronic conditions except for cancer.

Appendix Table 3 shows that those with a condition that was limiting their current activities, or the impact of current activities was unknown (i.e., question about impact on current activities was not answered) scored worse on the PROMIS-29 v2.0 physical and mental health summary scores than those without the condition.

The estimated PROMIS-29 v2.0 physical health and mental health summary scores were about 0.4 SDs below the U.S. general population average in Sample 1 (Table 4). This is consistent with the fact that Sample 1 is less healthy than the U.S. general population [34]. Similarly, and consistently, the PROMIS global physical health score was about 0.5 SD below the general population mean while the PROMIS global mental health score was about 0.3 SD below. The estimated PROMIS-29 v2.0 physical health summary score was about 0.1 SD below the U.S. general population average while the estimated PROMIS-29 v2.0 mental health score was at the general population average in Sample 2. In contrast, the SF-36 physical component summary score was 0.4 SD below the U.S. general population mean while the SF-36 mental component summary score was 0.2 SD below.

## Discussion

Because of the value and associated demand for bottom-line indicators, the SF-36 physical and mental health component summary scores [35] and PROMIS global physical health and mental health scales [24, 36] are widely used [37]. This study provides PROMIS-29 v2.0 physical health and mental health summary scores that are extremely reliable and have associations with other health-related quality of life measures and chronic conditions that are congruent with a-priori hypotheses. For example, the corresponding PROMIS-29 v2.0 and SF-36 physical and mental health summary scores correlated strongly with one another ( $r = 0.82$  for both in Sample 2).

The PROMIS-29 v2.0 physical and mental health summary scores have clear advantages over existing summary scores. First, the PROMIS v2.0 summary health measures are more reliable than the PROMIS global health summary scores (0.93 and 0.95 vs 0.79 for physical health and 0.0.97 and 0.98 vs 0.86 for mental health) [24, 36]. Second, the new summary scores were constructed allowing physical and mental health to be correlated rather than forcing a zero correlation between them as was the case for the SF-36 summary scores [35]. This is a critical difference because mental health scales are negatively weighted on the SF-36 physical health component summary score, and physical health scales receive negative weighting on the SF-36 mental health component summary score. This leads to inconsistent results between SF-36 scale scores and the summary scores when there is a consistent pattern of responses for the 8 SF-36 scale score (i.e., a majority of or all high scores or low scores) [38]. Allowing the underlying physical and mental health summary scores to be correlated reflects the reality of health and eliminates the inconsistency between scale scores and summary measures [17].

The PROMIS-29 v2.0 now yields 7 multi-item scale scores, a pain intensity item score, and physical and mental health summary scores. The factor scoring coefficients for estimating the summary scores are provided in Table 1, but more extensive information about scoring is available at [www.healthmeasures.net](http://www.healthmeasures.net) [39]. In addition, algorithms have been developed in the PROMIS project to estimate the EQ-5D-3L [25] and the HUI-3 [34] from the PROMIS-29 scales. Preference-based scoring functions can also be estimated directly from the PROMIS-29 [40–42].

While the results of this study provide strong support for some of the psychometric properties of the PROMIS-29 v2.0 summary scores, further work is needed to assess the scoring system in different samples. In addition, we welcome comparisons of the approach used here with alternative methods for deriving summary scores.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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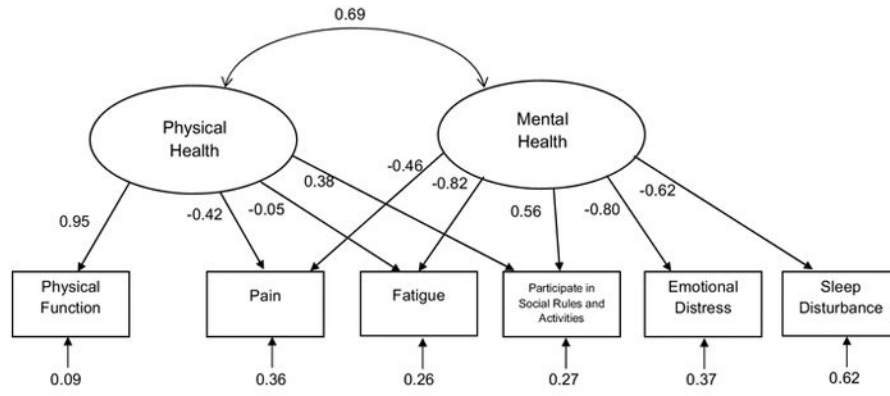
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**Figure 1.**  
Confirmatory Factor Analysis Standardized Estimates in Sample 1

**Table 1**

Standardized Factor Loadings and Scoring Coefficients (in parentheses) from Confirmatory Factor Analysis Model in Sample 1

Item	Physical	Mental
Physical function	0.95 (0.87)	0.00& (-.015)
Pain *	-0.42 (-.09)	-0.46 (-.15)
Ability to participate in social roles and activities	0.38 (0.11)	0.56 (0.25)
Fatigue	-0.05 (-.01)	-0.82 (-.35)
Emotional distress **	0.00& (0.003)	-0.80 (-.26)
Sleep disturbance	0.00& (0.002)	-0.62 (-.14)

\* Pain is average of pain intensity item and pain interference scale.

\*\* Emotional distress is average of anxiety and depressive symptoms.

& Fixed.

Note: Estimated correlation among physical and mental health factors was 0.694

**Table 2**

Product-moment Correlations of PROMIS-29 v2.0 Physical and Mental Health Summary Scales with Other Health Variables in Sample 1 ( $p < .0001$  except where noted)

Measure	PROMIS-29 Physical Health	PROMIS-29 Mental Health
EQ-5D-3L *	0.82	0.73
HUI-3	0.73	0.67
Ambulate	0.54	0.39
Dexterity	0.41	0.36
Emotion	0.43	0.56
Cognition	0.52	0.52
Pain	0.61	0.44
Vision	0.28	0.25
Hearing	0.35	0.31
Speech	0.38	0.37
Number of Chronic Conditions **	-0.50	-0.45
Male gender	-0.07	-0.05 ( $p=0.0071$ )
Age	-0.06 ( $p=0.0005$ )	-0.08

\* Predicted from PROMIS global health items (Revicki et al., 2009)

\*\* Hypertension, angina, coronary artery disease, heart failure, heart attack, stroke, liver disease, kidney disease, arthritis, migraines, asthma, chronic lung disease, diabetes, cancer, depression, anxiety, alcohol or drug problem, sleep disorder, HIV/AIDS, spinal cord injury, and multiple sclerosis.

**Table 3**

Product-moment Correlations of PROMIS-29 v2.0 Physical and Mental Health Summary Scales with Other Health Variables in Sample 2 ( $p < .0001$  except where noted)

Measure	PROMIS-29 Physical Health	PROMIS-29 Mental Health
SF-36 physical function	0.74	0.40
SF-36 role-physical	0.79	0.57
SF-36 bodily pain	0.84	0.53
SF-36 general health	0.72	0.59
SF-36 vitality	0.72	0.72
SF-36 social function	0.70	0.68
SF-36 role-emotional	0.62	0.52
SF-36 mental health	0.53	0.80
SF-36 physical component summary score	0.82	0.38
SF-36 mental component summary score	0.54	0.82
SF-6D	0.80	0.74
Number of chronic conditions *	-0.53	-0.42
Male gender	0.06	0.07 ( $p=0.0017$ )
Age	-0.04 ( $p=.0558$ )	0.25

\* Hypertension, angina, coronary artery disease, heart failure, heart attack, stroke, liver disease, kidney disease, arthritis, migraines, asthma, chronic lung disease, diabetes, cancer, depression, anxiety, alcohol or drug problem, sleep disorder, HIV/AIDS, and multiple sclerosis.

**Table 4**

Descriptive Statistics for PROMIS-29 v2.0 Physical and Mental Health Summary Scores in Sample 1 and Sample 2

Variable	Mean	SD	Minimum	Maximum
<b>Physical Health</b>				
PROMIS-29 v2.0 (Sample 1)	46.3	9.2	21.6	62.4
PROMIS Global (Sample 1)	44.8	9.4	16.0	67.7
PROMIS-29 v2.0 (Sample 2)	48.6	8.9	22.3	61.9
SF-36 v2 Physical Component Summary Score (Sample 2)	46.1	11.2	8.3	69.4
<b>Mental Health</b>				
PROMIS-29 v2.0 (Sample 1)	45.7	9.5	19.5	62.3
PROMIS Global (Sample 1)	46.6	9.7	21.1	67.6
PROMIS-29 v2.0 (Sample 2)	50.2	9.2	20.4	62.2
SF-36 v2 Mental Components Summary Score (Sample 2)	47.7	12.4	-3.6	71.7

**Appendix Table 1**

Product-Moment Correlations Among PROMIS-29 Scales and Pain Intensity Item in Sample 1 (top) and Sample 2 (bottom)

	Pain interference	Physical function	Pain intensity	Ability to participate in social roles	Anxiety	Depressive symptoms	Fatigue
Pain interference	1.00						
Physical function	-.74	1.00					
Pain intensity	0.67	-.56	1.00				
Ability to participate in social roles	-.75	0.73	-.54	1.00			
Anxiety	0.59	-.50	0.45	-.64	1.00		
Depressive symptoms	0.59	-.50	0.45	-.63	0.82	1.00	
Fatigue	0.67	-.59	0.52	-.71	0.64	0.63	1.00
Sleep disturbance	0.49	-.40	0.42	-.47	0.47	0.48	0.54

	Pain interference	Physical function	Pain intensity	Satisfaction with participation in social roles	Anxiety	Depressive symptoms	Fatigue
Pain interference	1.00						
Physical function	-.60	1.00					
Pain intensity	0.78	-.63	1.00				
Satisfaction with participation in social roles	-.49	0.62	-.54	1.00			
Anxiety	0.40	-.31	0.43	-.45	1.00		
Depressive symptoms	0.40	-.34	0.44	-.48	0.81	1.00	
Fatigue	0.55	-.55	0.58	-.61	0.58	0.62	1.00
Sleep disturbance	0.43	-.35	0.48	-.52	0.49	0.53	0.62

Appendix Table 2

Mean Scores on PROMIS-29 V 2.0 Physical and Mental Health Summary Scores by Chronic Conditions in Sample 1

Condition	Physical Health			Mental Health		
	Without condition	With condition	t-test	Without condition	With condition	t-test
Ever told by doctor you have ...						
High blood pressure (hypertension)	47.3 (9.4) n = 1975	43.0 (9.3) n = 1024	t(2997)= 11.7, p<.0001	47.8 (9.3) n = 1975	45.0 (9.3) n = 1024	t(2997)= 8.0, p<.0001
Chest pain (angina)	46.6 (9.5) n = 2705	39.1 (7.6) n = 294	t(401.4)= 15.6, p<.0001	47.5 (9.3) n = 2705	40.7 (7.5) n = 294	t(397.7)= 14.4, p<.0001
Hardening of the arteries (CAD)	46.2 (9.6) n = 2866	38.1 (7.1) n = 133	t(155.4)= 12.6, p<.0001	47.1 (9.4) n = 2866	41.3 (7.8) n = 133	t(2997)= 7.1, p<.0001
Heart failure or congestive heart failure	46.2 (9.6) n = 2888	36.8 (5.7) n = 111	t(134.6)= 16.4, p<.0001	47.2 (9.4) n = 2888	39.6 (6.6) n = 111	t(127.5)= 11.5, p<.0001
Heart attack (myocardial infarction)	46.2 (9.6) n = 2859	39.3 (8.1) n = 140	t(2997)= 8.4, p<.0001	47.1 (9.4) n = 2859	42.3 (8.0) n = 140	t(2997)= 5.9, p<.0001
Stroke or transient ischemic attack (TIA)	46.1 (9.5) n = 2913	37.6 (7.6) n = 86	t(2997)= 8.1, p<.0001	47.1 (9.4) n = 2913	40.1 (7.7) n = 86	t(2997)= 6.8, p<.0001
Liver disease, hepatitis, or cirrhosis	46.1 (9.6) n = 2895	38.5 (7.8) n = 104	t(2997)= 8.0, p<.0001	47.1 (9.4) n = 2895	41.3 (7.9) n = 104	t(2997)= 6.2, p<.0001
Kidney disease	46.1 (9.6) n = 2899	37.6 (6.7) n = 100	t(113.2)= 12.1, p<.0001	47.1 (9.4) n = 2899	40.2 (7.0) n = 100	t(111.7)= 9.5, p<.0001
Arthritis or rheumatism	47.2 (9.4) n = 2397	40.6 (8.5) n = 602	t(1005)= 16.7, p<.0001	47.9 (9.3) n = 2397	42.9 (8.7) n = 602	t(2997)= 11.9, p<.0001
Migraines or severe headaches	46.4 (9.6) n = 2520	43.0 (9.2) n = 479	t(2997)= 7.1, p<.0001	47.7 (9.3) n = 2520	42.4 (8.8) n = 479	t(2997)= 11.7, p<.0001
Asthma	46.5 (9.6) n = 2502	42.5 (9.0) n = 497	t(2997)= 8.5, p<.0001	47.5 (9.4) n = 2502	43.6 (8.8) n = 497	t(2997)= 8.4, p<.0001
Chronic lung disease (COPD), chronic bronchitis or emphysema	46.3 (9.5) n = 2837	38.1 (7.5) n = 162	t(191.8)= 13.2, p<.0001	47.2 (9.4) n = 2837	41.0 (8.2) n = 162	t(2997)= 8.2, p<.0001
Diabetes or high blood sugar or sugar in your urine	46.5 (9.5) n = 2678	40.8 (9.2) n = 321	t(2997)= 10.2, p<.0001	47.3 (9.4) n = 2678	43.5 (8.9) n = 321	t(2997)= 6.8, p<.0001
Cancer (other than non-melanoma skin cancer)	46.0 (9.6) n = 2860	43.2 (9.3) n = 139	t(2997)= 3.3, p<.00010	46.9 (9.43) n = 2860	46.0 (8.6) n = 139	t(2997)= 1.1, p=0.2412
Depression	47.0 (9.6) n = 2267	42.1 (8.7) n = 732	t(1344.5)= 12.9, p<.0001	48.8 (9.0) n = 2267	40.8 (8.0) n = 732	t(1372.6)= 22.8, p<.0001
Anxiety	46.6 (9.6) n = 2357	43.2 (9.1) n = 642	t(2997)= 8.0, p<.0001	48.4 (9.2) n = 2357	41.3 (8.0) n = 642	t(1140.7)= 19.4, p<.0001
Alcohol or drug problem	46.1 (9.6) n = 2847	40.6 (7.6) n = 152	t(177.5)= 8.4, p<.0001	47.2 (9.4) n = 2847	40.6 (7.2) n = 152	t(179.7)= 10.8, p<.0001
Sleep disorder	46.5 (9.5) n = 2597	41.4 (8.8) n = 402	t(2997)= 10.0, p<.0001	47.8 (9.2) n = 2597	40.7 (8.0) n = 402	t(582.1)= 16.3, p<.0001
HIV or AIDS	46.0 (9.6) n = 2956	38.4 (7.5) n = 43	t(2997)= 5.1, p<.0001	47.0 (9.4) n = 2956	40.7 (7.7) n = 43	t(2997)= 4.3, p<.0001
Spinal cord injury	46.1 (9.5) n = 2917	36.0 (6.2) n = 82	t(92.1)= 14.2, p<.0001	47.1 (9.4) n = 2917	39.3 (5.9) n = 82	t(93)= 11.5, p<.0001
Multiple Sclerosis	46.1 (9.6) n = 2932	36.3 (4.5) n = 67	t(80.6)= 16.9, p<.0001	47.0 (9.4) n = 2932	41.3 (6.9) n = 67	t(71.7)= 6.5, p<.0001



Appendix Table 3

Mean Scores on PROMIS-29 Physical and Mental Health Summary Scores by Limited by Chronic Conditions in Sample 1

Condition	Physical Health				ANOVA
	Does not have condition	With condition, no limitation	With condition, unknown limitation	With condition, is limited	
<b>Current activities limited by..</b>					
High blood pressure (hypertension)	47.3 <sup>a</sup> n = 1975	45.7 <sup>a</sup> n = 637	35.5 <sup>b</sup> n = 14	38.8 <sup>b</sup> n = 373	F(3,2995)=96.7, p<.0001
Chest pain (angina)	46.6 <sup>a</sup> n = 2705	42.5 <sup>ab</sup> n = 99	33.8 <sup>c</sup> n = 3	37.5 <sup>bc</sup> n = 192	F(3,2995)=63.4, p<.0001
Hardening of the arteries (CAD)	46.2 <sup>a</sup> n = 2866	41.8 <sup>b</sup> n = 51	n=0	35.9 <sup>c</sup> n = 82	F(2,2996)=52.5, p<.0001
Heart failure or congestive heart failure	46.2 <sup>a</sup> n = 2888	39.2 <sup>ab</sup> n = 33	35.2 <sup>b</sup> n = 2	35.7 <sup>b</sup> n = 76	F(3,2995)=36.8, p<.0001
Heart attack (myocardial infarction)	46.2 <sup>a</sup> n = 2859	41.2 <sup>ab</sup> n = 62	34.1 <sup>c</sup> n = 8	38.1 <sup>bc</sup> n = 70	F(3,2995)=25.6, p<.0001
Stroke or transient ischemic attack (TIA)	46.1 <sup>a</sup> n = 2913	41.3 <sup>b</sup> n = 34	33.7 <sup>c</sup> n = 17	35.9 <sup>c</sup> n = 35	F(3,2995)=25.4, p<.0001
Liver disease, hepatitis, or cirrhosis	46.1 <sup>a</sup> n = 2895	41.4 <sup>b</sup> n = 46	34.0 <sup>c</sup> n = 24	37.7 <sup>bc</sup> n = 34	F(3,2995)=25.0, p<.0001
Kidney disease	46.1 <sup>a</sup> n = 2899	41.3 <sup>b</sup> n = 35	34.5 <sup>c</sup> n = 17	36.1 <sup>c</sup> n = 48	F(3,2995)=28.7, p<.0001
Arthritis or rheumatism	47.2 <sup>a</sup> n = 2397	47.3 <sup>a</sup> n = 162	34.5 <sup>c</sup> n = 46	38.5 <sup>b</sup> n = 394	F(3,2995)=130.2, p<.0001
Migraines or severe headaches	46.4 <sup>a</sup> n = 2520	47.2 <sup>a</sup> n = 163	34.5 <sup>c</sup> n = 22	41.3 <sup>b</sup> n = 294	F(3,2995)=37.3, p<.0001
Asthma	46.5 <sup>a</sup> n = 2502	47.1 <sup>a</sup> n = 189	34.0 <sup>c</sup> n = 24	40.2 <sup>b</sup> n = 284	F(3,2995)=52.2, p<.0001
Chronic lung disease (COPD), chronic bronchitis or emphysema	46.3 <sup>a</sup> n = 2837	42.0 <sup>b</sup> n = 47	35.4 <sup>c</sup> n = 22	36.8 <sup>c</sup> n = 93	F(3,2995)=42.5, p<.0001
Diabetes or high blood sugar or sugar in your urine	46.5 <sup>a</sup> n = 2678	44.2 <sup>a</sup> n = 164	34.8 <sup>c</sup> n = 43	38.0 <sup>b</sup> n = 114	F(3,2995)=52.1, p<.0001
Cancer (other than non-melanoma skin cancer)	46.0 <sup>a</sup> n = 2860	46.7 <sup>a</sup> n = 87	35.5 <sup>b</sup> n = 15	38.1 <sup>b</sup> n = 37	F(3,2995)=14.6, p<.0001
Depression	47.0 <sup>a</sup> n = 2267	45.8 <sup>a</sup> n = 307	34.8 <sup>c</sup> n = 29	39.8 <sup>b</sup> n = 396	F(3,2995)=82.5, p<.0001

Condition	Physical Health				ANOVA
	Does not have condition	With condition, no limitation	With condition, unknown limitation	With condition, is limited	
Anxiety	46.6 <sup>a</sup> n = 2357	46.5 <sup>a</sup> n = 265	35.3 <sup>c</sup> n = 13	41.0 <sup>b</sup> n = 364	F(3,2995)=42.9, p<.0001
Alcohol or drug problem	46.1 <sup>a</sup> n = 2847	44.1 <sup>a</sup> n = 63	34.4 <sup>c</sup> n = 19	39.3 <sup>b</sup> n = 70	F(3,2995)=22.0, p<.0001
Sleep disorder	46.5 <sup>a</sup> n = 2597	44.9 <sup>a</sup> n = 166	35.5 <sup>c</sup> n = 18	39.3 <sup>b</sup> n = 218	F(3,2995)=48.1, p<.0001
HIV or AIDS	46.0 <sup>a</sup> n = 2956	41.6 <sup>ab</sup> n = 10	34.0 <sup>c</sup> n = 10	39.0 <sup>bc</sup> n = 23	F(3,2995)=9.9, p<.0001
Spinal cord injury	46.1 <sup>a</sup> n = 2917	41.8 <sup>a</sup> n = 15	34.7 <sup>b</sup> n = 17	34.8 <sup>b</sup> n = 50	F(3,2995)=32.5, p<.0001
Multiple Sclerosis	46.1 <sup>a</sup> n = 2932	38.1 <sup>b</sup> n = 11	35.7 <sup>b</sup> n = 15	36.1 <sup>b</sup> n = 41	F(3,2995)=23.1, p<.0001

Condition	Mental Health				ANOVA
	Does not have condition	With condition, no limitation	With condition, unknown limitation	With condition, is limited	
<b>Current activities limited by..</b>					
High blood pressure (hypertension)	47.8 <sup>a</sup> n = 1975	47.7 <sup>a</sup> n = 637	41.6 <sup>b</sup> n = 14	40.5 <sup>b</sup> n = 373	F(3,2995)=72.9, p<.0001
Chest pain (angina)	47.5 <sup>a</sup> n = 2705	43.5 <sup>ab</sup> n = 99	36.1 <sup>b</sup> n = 3	39.3 <sup>b</sup> n = 192	F(3,2995)=54.3, p<.0001
Hardening of the arteries (CAD)	47.1 <sup>a</sup> n = 2866	45.6 <sup>a</sup> n = 51	n=0	38.6 <sup>b</sup> n = 82	F(2,2996)=34.4, p<.0001
Heart failure or congestive heart failure	47.2 <sup>a</sup> n = 2888	41.9 <sup>a</sup> n = 33	40.1 <sup>a</sup> n = 2	38.6 <sup>a</sup> n = 76	F(3,2995)=24.6, p<.0001
Heart attack (myocardial infarction)	47.1 <sup>a</sup> n = 2859	44.8 <sup>ab</sup> n = 62	39.2 <sup>c</sup> n = 8	40.4 <sup>bc</sup> n = 70	F(3,2995)=14.4, p<.0001
Stroke or transient ischemic attack (TIA)	47.1 <sup>a</sup> n = 2913	43.0 <sup>a</sup> n = 34	38.1 <sup>b</sup> n = 17	38.2 <sup>b</sup> n = 35	F(3,2995)=17.5, p<.0001
Liver disease, hepatitis, or cirrhosis	47.1 <sup>a</sup> n = 2895	43.9 <sup>a</sup> n = 46	39.3 <sup>b</sup> n = 24	39.1 <sup>b</sup> n = 34	F(3,2995)=15.1, p<.0001
Kidney disease	47.1 <sup>a</sup> n = 2899	44.1 <sup>ab</sup> n = 35	40.0 <sup>bc</sup> n = 17	37.5 <sup>c</sup> n = 48	F(3,2995)=21.0, p<.0001
Arthritis or rheumatism	47.9 <sup>a</sup> n = 2397	49.0 <sup>a</sup> n = 162	39.2 <sup>b</sup> n = 46	40.8 <sup>b</sup> n = 394	F(3,2995)=83.5, p<.0001

Condition	Mental Health				ANOVA
	Does not have condition	With condition, no limitation	With condition, unknown limitation	With condition, is limited	
Migraines or severe headaches	47.7 <sup>a</sup> n = 2520	47.1 <sup>a</sup> n = 163	40.8 <sup>b</sup> n = 22	39.8 <sup>b</sup> n = 294	F(3,2995)=69.3, p<.0001
Asthma	47.5 <sup>a</sup> n = 2502	47.4 <sup>a</sup> n = 189	39.4 <sup>b</sup> n = 24	41.5 <sup>b</sup> n = 284	F(3,2995)=41.9, p<.0001
Chronic lung disease (COPD), chronic bronchitis or emphysema	47.2 <sup>a</sup> n = 2837	43.1 <sup>b</sup> n = 47	40.8 <sup>b</sup> n = 22	40.1 <sup>b</sup> n = 93	F(3,2995) = 23.5, p<.0001
Diabetes or high blood sugar or sugar in your urine	47.3 <sup>a</sup> n = 2678	47.3 <sup>a</sup> n = 164	39.9 <sup>b</sup> n = 43	39.4 <sup>b</sup> n = 114	F(3,2995) = 34.5, p<.0001
Cancer other than non-melanoma skin cancer	46.9 <sup>a</sup> n = 2860	49.2 <sup>a</sup> n = 87	40.7 <sup>b</sup> n = 15	40.4 <sup>b</sup> n = 37	F(3,2995) = 10.0, p<.0001
Depression	48.8 <sup>a</sup> n = 2267	45.5 <sup>b</sup> n = 307	40.5 <sup>c</sup> n = 29	37.2 <sup>d</sup> n = 396	F(3,2995) = 216.1, p<.0001
Anxiety	48.4 <sup>a</sup> n = 2357	45.1 <sup>a</sup> n = 265	39.2 <sup>b</sup> n = 13	38.6 <sup>b</sup> n = 364	F(3,2995) = 138.5, p<.0001
Alcohol or drug problem	47.2 <sup>a</sup> n = 2847	42.8 <sup>b</sup> n = 63	39.0 <sup>b</sup> n = 19	39.0 <sup>b</sup> n = 70	F(3, 2995) = 26.4, p<.0001
Sleep disorder	47.8 <sup>a</sup> n = 2597	44.8 <sup>a</sup> n = 166	39.5 <sup>b</sup> n = 18	37.7 <sup>b</sup> n = 218	F(3,2995) = 92.3, p<.0001
HIV or AIDS	47.0 <sup>a</sup> n = 2956	44.9 <sup>ab</sup> n = 10	39.4 <sup>b</sup> n = 10	39.4 <sup>b</sup> n = 23	F(3,2995) = 7.2, p<.0001
Spinal cord injury	47.1 <sup>a</sup> n = 2917	42.0 <sup>b</sup> n = 15	39.7 <sup>b</sup> n = 17	38.4 <sup>b</sup> n = 50	F(3,2995) = 19.0, p<.0001
Multiple Sclerosis	47.0 <sup>a</sup> n = 2932	41.9 <sup>ab</sup> n = 11	40.8 <sup>b</sup> n = 15	41.3 <sup>ab</sup> n = 41	F(3,2995) = 8.1, p<.0001

Duncan's Multiple Range Test

NOTE: This test controls the Type I comparison wise error rate, not the experiment wise error rate.

Means with the same letter are not significantly different.