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To cite this article: Dr Mazi Rasulnia, Mr Billy Stephen Burton, Mr Robert P Ginter, Dr Tracy Y Wang, Dr Roy Alton Pleasants, Dr Cynthia L Green & Dr Njira Lugogo (2017): Assessing the Impact of a Remote Digital Coaching Engagement Program on Patient Reported Outcomes in Asthma, Journal of Asthma, DOI: [10.1080/02770903.2017.1362430](https://doi.org/10.1080/02770903.2017.1362430)

To link to this article: <http://dx.doi.org/10.1080/02770903.2017.1362430>



Accepted author version posted online: 11 Aug 2017.



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Title: Assessing the Impact of a Remote Digital Coaching Engagement Program on Patient Reported Outcomes in Asthma

Running Head: Impact of Remote Engagement Program on Asthma PROs

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Abstract

Background: Low adherence and poor outcomes provide opportunity for digital coaching to engage patients with uncontrolled asthma in their care to improve outcomes.

Objectives: To examine the impact of a remote digital coaching program on asthma control and patient experience.

Methods: We recruited 51 adults with uncontrolled asthma, denoted by albuterol use of > 2 times per week and/or exacerbations requiring corticosteroids, and applied a 12-week patient-centered remote digital coaching program using a combination of educational pamphlets, symptom trackers, best peak flow establishment, physical activity, and dietary counseling, as well as coaches who implemented emotional enforcement to motivate disease self-management through telephone, text, and email. Baseline and post-intervention measures were quality of life (QOL), spirometry, Asthma Control Test (ACT), Asthma Symptom Utility Index (ASUI), rescue albuterol use, and exacerbation history.

Results: Among 51 patients recruited, 40 completed the study. Eight subjects required assistance reading medical materials. Significant improvements from baseline were observed for PROMIS mental status ($p = 0.010$), body weight and outpatient exacerbation frequency ($p = 0.028$). The changes from baseline in ACT ($p = 0.005$) was statistically significant but did not achieve the pre-specified minimum clinically important difference (MCID). Whereas for ASUI, the MCID and statistical significance were achieved. Spirometry and rescue albuterol use were no different.

Conclusion: A patient-oriented, remote digital coaching program that utilized trained health coaches and digital materials led to statistically significant improvement in mental status, outpatient exacerbations, body weight, and ASUI. Digital coaching programs may improve some outcomes in adults with uncontrolled asthma.

Key Words: Alternative Medicine, Education, Management / Control, Quality of Life, Treatment

I. Introduction:

Even though effective therapies are widely available for patients with asthma, many patients do not achieve their treatment goals. There is a growing recognition that actively engaging patients with asthma in their care is a critical element to improve quality health outcomes. The general expectation is that when patients are armed with the right information and tools, they will have higher quality care interactions, adhere to treatment recommendations, and be better stewards of their health. In fact, studies have shown that activated patients have better outcomes and are better equipped to manage their own diseases. [1,2] Additionally, engaged patients rate their care and associated providers higher, therefore suggesting that they have more favorable experiences overall. [1,2]

It has become apparent to healthcare professionals and organizations that the majority of healthcare now occurs outside of the brief in-clinic interactions between clinicians and patients. The average time spent face-to-face with patients by physicians during clinic visits is about 13 minutes, which may be inadequate to educate, inform, and activate patients with chronic conditions. [3]

Due to the various behaviors that contribute to the manifestation of chronic disease conditions such as asthma, patients living with these conditions could benefit from the utilization of patient engagement and coaching strategies. Behavioral theories suggest that quality information along with frequent reminders and reinforcement are strongly associated with sustained behavior changes.[4] Various strategies have been used to achieve these goals, particularly the use of digital and coaching tools for various chronic diseases.

Pack Health LLC and the Duke University Asthma, Allergy, and Airways Center developed a remote digital coaching program with the specific objectives to help empower and engage patients with asthma, as well as improve their clinical outcomes. We evaluated the impact of this multi-faceted high touchpoint digital coaching program on outcomes in a group of adults with uncontrolled asthma.

II. Materials and Methods

1. Study Design

Our design was prospective, and followed a cohort receiving the intervention over 12 weeks. We had two main objectives: (1) test the impact of a patient engagement solution on patient's quality of life (QOL) and outcomes, and (2) evaluate the correlation between a patient reported outcome measure and clinical outcomes. Specifically, we hypothesized a mean change in ACT score of -4.0 and change in ASUI score of > 0.90 .

2. Setting, Participants, Enrollment

Participants were both recruited and enrolled in the intervention by the Duke University Asthma, Allergy, and Airways Center during a nine-month period. The eligibility criteria for participants were as follows: (1) physician diagnosis of current asthma; (2) their asthma was classified as "uncontrolled" based upon albuterol use of > 2 times per week and/or asthma exacerbations requiring systemic corticosteroids; and (3) the participant was at least 18 years of age. Patients were excluded from the intervention if they had: (1) significant current alcohol consumption of more than three alcoholic drinks per day or active substance abuse; (2) a chronic disease (other than asthma) that in the opinion of the investigator would prevent participation in the trial or put the participant at risk; (3) a diagnosis of cancer with ongoing treatment; or (4) life expectancy of less than one year. During the enrollment process, patients provided written consent, completed baseline questionnaires, underwent a physical examination, clinical history, and ATS standard spirometry. The protocol was approved by the IRB and all subjects provided written informed consent. All personal identifying information was stored in a HIPAA-secured database. In all, 51 individuals were identified and consented to participate in the intervention, with 40 (78.4%) completing the study.

3. Intervention

The duration of the intervention was 12 weeks. Each patient was given standard printed information and management-assisting tools in addition to a personal health advisor/coach, who

was in weekly communication with the participant to provide support, motivation, additional education, and accountability.

Printed material and tools included: (1) two informational booklets, (asthma self-management and healthy eating principles); (2) an interactive booklet encouraging participants to contemplate their goals, external facilitators, and external barriers; (3) booklets in which individuals were asked to track medication adherence, diet, and physical activity; (4) peak flow meter; (5) pedometer; (6) magnet reinforcing healthy eating principles; (7) three stickers, one red to help distinguish the participant's rescue inhaler, one green to help distinguish the participant's maintenance inhaler, and one peak flow meter sticker to mark ranges; (8) one-page informational cards, termed "mailers", focusing on individual topics of asthma management sent weekly. A curriculum of easy to read, written materials were provided for participants at the beginning of the study and included a unique topic for 11 of the 12 weeks as follows; 1) what is asthma? 2) motivation, 3) asthma action plan, 4) improving environments, 5) asthma medications, 6) exercise, 7) healthy living, 8) eating right, 9) off week, 10) stop smoking, 11) managing costs, and 12) graduation.

Participants were engaged weekly by their health advisor through telephone, text message, and/or email based on availability and participant preference to support the information they had already received. The health advisor would use motivational interviewing techniques to discover participant barriers and foster the participant's creation of solutions that worked for them. [5] Various processes of change from the Transtheoretical model would be taught and/or suggested as strategies to overcome barriers and achieve health behaviors as needed. [6] One small goal for the upcoming week would be decided by the participant at the end of each session. Three text messages would be sent to the participant weekly between telephone sessions. All messages were based on standard aspects of the week's topic or on personal matters discussed with the health advisor. The aim of the messages was to encourage, remind, or hold the patient accountable to their goal for the week-long term goal(s). If the participant chose email but not text message, 2--3 emails would be sent per week. Health advisors responded to any inbound communication (e.g., an additional question, update, or request outside of the scheduled interactions) received from the participants. For matters potentially of clinical concern, the

participant was encouraged to contact their clinician, and the health advisor followed up on the matter the following week. At the end of the 12-week program, participants returned to complete post-intervention questionnaires, a clinical history, physical examination, and spirometry.

4. Metrics

For each enrolled subject, the following were collected at baseline and end of the 12-week study: socio-demographics (age, gender, highest educational level, height, weight, BMI, ethnicity), tobacco history, comorbidities, age of asthma diagnosis, respiratory medications, asthma severity per doctor, and self-reported asthma severity. The Patient-Reported Outcomes Measurement Information System (PROMIS) Global-10 short form was used to assess general domains of health and functioning including overall physical health, mental health, social health, pain, fatigue, and overall perceived QOL. [7,8] In addition, asthma impact questionnaires were obtained at baseline and end of study: Asthma Control Test (ACT), a five item questionnaire to determine if asthma symptoms are well controlled; Asthma Symptom Utility Index (ASUI), an eleven item patient preference-based scale assessing frequency and severity of selected asthma-related symptoms and treatment side effects; and Work Productivity and Activity Impairment Questionnaire (WPAI), a six item instrument to measure impairments in both paid and unpaid work. [9,10,11] Spirometry (ATS standard) was performed at baseline and at the end of the study. If spirometry had been performed within 1 month for standard of care, it was not repeated.

Participants were asked to describe their understanding of asthma, and understanding was measured binarily based on whether a participant accurately understood the following concepts identified by our team as crucial to asthma understanding: (1) the definition of the condition (including inflamed airways); (2) symptoms such as shortness of breath, wheezing, and chest pain; (3) proper situations in which to use various inhalers; and (4) how triggers can bring on an attack. Motivation to improve health was measured by 1 item, which read: “On a scale of 1--5, with 5 being ‘very motivated’ and 1 being ‘not at all motivated’, how motivated are you to improve your health?” Other metrics included: the number of emergency department visits a patient had in the past 3 months, the number of medication doses skipped per week, the number of moderate-to-vigorous physical activity (MVPA) sessions per week, and the number of meals

that follow USDA's healthy plate guidelines (defined as $\frac{1}{2}$ non-starchy vegetables, $\frac{1}{4}$ starchy vegetables *and/or* grains, $\frac{1}{4}$ protein, optional small portion of fruit, and an unsweetened beverage per week). Lastly, over the 12 weeks of the study, participants were asked to establish best peak flow with a peak flow meter provided to them. They were also asked to monitor their daily symptoms through their daily symptom tracker.

5. Statistical Analyses

Data were summarized at baseline and 12 weeks using the mean and standard deviation (SD) for normally distributed variables or the median and range for non-normally distributed continuous variables and counts with percentages for categorical data. Data were evaluated for normality using the Kolmogorov-Smirnov test and normality plots. The change from baseline to end of study (12 weeks) for continuous variables was tested using a paired t-test if normally distributed or the Wilcoxon signed rank test otherwise. The change in categorical variables was evaluated using McNemar's test (2×2 tables) for paired data or Bowker's test of symmetry (n-way tables, where $n > 2$). All statistical tests were two-sided using a significance level of 0.05. Data were analyzed using SAS Version 9.4 (SAS, Cary, NC).

III. Results

Fifty-one adult patients with uncontrolled asthma were enrolled in the study and 40 (78.4%) completed the study. Eleven subjects dropped out of the study due to lack of interest in completing the 12-week program (did not participate in majority of weekly interactions with the health coach or did not complete the post-study visit). Subject baseline characteristics are shown in Table 1. Characteristics of subjects completing the study include a median age of 52 years, 30 (75%) females, and 25 (62.5%) African Americans. The most common comorbidities were GERD (67.5%), hypertension (37.5%), morbid obesity (50.0%) and allergic rhinitis (65.0%). Also, mild or moderate persistent asthma was found in 77.5% of subjects. For health literacy, 31 (77.5%) subjects reported never needing assistance with reading medical materials, whereas 9 (22.5%) subjects said they needed help at sometimes or always with understanding written health information.

Outcome measures at baseline and end of study are shown in Table 2. For the primary study outcome, there was a statistically significant decrease in periods of acute asthma worsening not requiring an acute care visit ($p = 0.028$). In contrast, there was no difference in asthma exacerbations requiring an ED visit or hospitalization ($p = 1.000$). Among secondary outcomes, there were statistically significant changes in ASUI ($p = 0.019$) and PROMIS mental health ($p = 0.010$). Change in asthma severity category as reported by the subjects did not change significantly between baseline and post study. Although the mean increase in ACT (-1.68) scores was statistically significant, the minimum clinically important differences of -4.0 was not achieved. The change in ASUI between baseline and post-study did meet the minimum clinically significant difference (≥ 0.09) and was statistically significantly improved. There was no difference in baseline peak flow and end of study (measured at home). Similarly, there was no significant change in forced expiratory volume 1 second (FEV1) or FEV1/FVC (forced vital capacity) in subjects between baseline and post-study.

In addition to improvements in asthma outcomes, many participants subjectively indicated that the emphasis on diet and exercise was positive. There was a decrease in the mean BMI from baseline (34.9 kg/m^2) to post-study (33.8 kg/m^2) that was approaching statistical significance ($p = 0.056$). However, the decrease in body weight from baseline (97.3 kg) to post-study (93.0 kg) was significant ($p = 0.034$). Among 35 subjects reporting adherence, 11 (31.4%) indicated that the program improved their asthma medication compliance. Among the five patients who were current smokers, 1 (16.7%) successfully quit tobacco with the aid of the Pack Health program. Twenty-one subjects reported that they had established their best peak expiratory flow rate during the study.

IV. Discussion

The use of digital coaching and telehealth in asthma management offers multiple ways to aid patient education and counseling; extending face-to-face clinician visits. We developed a 12-week remote digital coaching program that involved the use of trained health advisors who interacted weekly with each subject through digital technology, reviewed written asthma educational materials, and set goals on general health, diet, exercise, and obtaining control of

their asthma. For the primary outcome, among the forty participants who completed the study, there was a significant decrease in episodes of worsening asthma not requiring acute care visits. However, there was no effect on more severe episodes of asthma worsening defined by an emergency department visit or hospitalization. For secondary outcomes, there was a clinically significant change in ASUI based on pre-specified criteria; however, this change did not meet the minimally clinically importance difference for the ACT. Furthermore, the PROMIS mental health scores significantly improved. There were 11 subjects who self-reported that their medication compliance had improved with the program, a successful outcome by any measure. Also, nearly half of the study participants established their best peak flow rate to aid in self-monitoring.

Digital health coaching typically involves the use of telephone communication, video- and internet based models of care. A 2011 meta-analysis that evaluated the impact of telehealth on asthma outcomes found no effect on QOL, asthma symptoms, or spirometry, however, there was a positive effect on the risk of asthma exacerbations requiring hospitalization. [12] However, a more recent one-year study in a group of adults with asthma using Internet technology closely aligned with increased provider/patient found that there was improvement in asthma control and QOL, but not spirometry or change in inhaled steroid. [13] Related to participating in our patient engagement intervention, we did see a difference in asthma flares not requiring an ED visit or hospitalization (home management or urgent care visit).

The Global Initiative for Asthma (GINA) guidelines support a shared-care approach to asthma to improve outcomes. [14] The guidelines state that patients should be encouraged to participate in their treatment, and given the opportunity to express themselves and have a partnership that is individualized to each patient. Many of the health behaviors that can aid asthma control such as recognizing deterioration in symptoms (self-monitoring) and reacting appropriately, adhering to maintenance therapies, stopping smoking and avoiding triggers, and healthy lifestyle promotion (exercise, diet, stress reduction) [15] were included in this intervention.

According to GINA, a person's willingness and ability to engage in self-management may vary depending on factors such as ethnicity, literacy, understanding of health concepts (health literacy), numeracy, beliefs about asthma and medications, desire for autonomy, and the health care system. [14] The materials we prepared were written at an 8th grade level and we identified persons who had difficulties in understanding written health materials using a standardized health literacy tool at the beginning of the study. The weekly interactions of the trained health coaches with study subjects through telephone conversations would likely be able to enhance health literacy.

We used the PROMIS (Patient-Reported Outcomes Measurement Information System) to assess global health measures represent an attractive option for researchers and clinicians seeking the patient's overall perspective on his or her health. Although there was no statistically significant improvement in physical well-being, our intervention did improve mental health overall well-being.

Adherence to key GINA guideline recommendations such as medication adherence, determination of a best peak flow, and establishment of an asthma action plan are notoriously poor in many patients. [14] We were able to get slightly more than half of the subjects to establish their best peak flow rate, many for the first time. Although, actual development of a written asthma action plan was not included in our program, the establishment of the best peak flow is an important premise to develop such a written strategy. About one-fourth of the subjects reported that their medication adherence improved as a result of the program. Medication adherence is one of the biggest challenges to achieve asthma control.

Limitations of the study include a short study period, small sample size, an ~ 20% dropout rate, lack of a cost analysis, and a study sample that was significantly more females than males. A larger sample size and longer intervention may have been more likely to impact acute care visits related to asthma. Females may be more likely than males to accept an intervention that promotes empowerment and self-management of asthma.

VI. Conclusions

We undertook a study to look at the impact of a remote digital coaching program to improve outcomes in adults with uncontrolled asthma that consisted of a combination of a written curriculum, self-monitoring, telephone and text interactions, and frequent interactions with a health coach to facilitate patient engagement. We observed the intervention to improve several outcomes including fewer mild episodes of acute worsening asthma, improvement in medication compliance, better mental health, weight loss, and statistically significant improvement in one asthma symptom score. As a consequence of this program, there was an improvement in asthma flares not requiring an ED visit or hospitalization. However, this multifaceted intervention did not achieve the minimally clinically significant improvement in ACT nor statistically significant change in breathing tests. Some clinical and other measures were improved as a consequence of this patient engagement program in a group of adults with uncontrolled asthma.

VII. Acknowledgements

The authors gratefully acknowledge the following individuals for their assistance in the above study: Ana Quinn MBA and Gretchen Sanders for their roles in project management; and Sean Bowman MPH for his assistance with the preparation of the submission packet.

VIII. Declarations of Interest

The authors declare the following interests:

Dr. Rasulnia, Mr. Burton, and Mr. Ginter are employees of Pack Health, LLC: a for-profit organization that uses the evaluated intervention in the service they provide.

Drs. Wang, Pleasants, Green, and Lugogo report no conflicts of interest.

This study was funded by a grant from Genentech, LLC.

IX. References

1. Greene J, Hibbard JH. Why does patient activation matter? An examination of the relationships between patient activation and health-related outcomes. *J Gen Intern Med*. 2012;27(5):520-6. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/22127797>
2. Hibbard JH, Greene J. What the evidence shows about patient activation: better health outcomes and care experiences; fewer data on costs. 2013;32(2):207-14. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/23381511>
3. Gottschalk A, Flocke SA. Time spent in face-to-face patient care and work outside the examination room. *Ann Fam Med*. 2005;3(6):488-93.
4. Coulter A. Patient Engagement- What Works? *J Ambul Care Manage*. 2012;35(2):80-89.
5. Miller WR, Rose GS. Toward a theory of motivational interviewing. *Am Psychol*. 2009; 64(6): 527--537. Available from: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2759607/>
6. Prochaska JO, Redding CA, Evers KE. *Health Behavior and Health Education*. 4th ed. Glanz K, Rimer BK, Viswananth K, Editors. San Francisco, CA: Jossey-Bass; 2008. Chapter 5, The trans-theoretical model and stages of change; p. 97--121.
7. Schalet BD et al. (2015). Linking physical and mental health summary scores from the Veterans RAND 12-item health survey (VR-12) to the PROMIS global health scale. *J Gen Intern Med*. 2015;30:1524-30. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/26179820>
8. Hays RD, Bjorner JB, Revicki DA, Spritzer K, Cella D. Development of physical and mental health summary scores from the Patient Reported Outcomes Measurement Information System (PROMIS) global items. *Qual Life Res*. 2009;18:873--80. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/19543809>
9. Nathan RA, Sorkness CA, Kosinski M, Schatz M, Li JT, Marcus P, Murray JJ, Pendergraft TB. Development of the asthma control test: a survey for assessing asthma control. *J Allergy Clin Immunol*. 2004;113(1):59-65. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/14713908>

10. Revicki DA, Leidy NK, Brennan-Diemer F, Sorensen S, Togias A. Integrating patient preferences into health outcomes assessment: the multiattribute Asthma Symptom Utility Index. *Chest*. 1998;114(4):998-1007. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/9792568>
11. Reilly MC, Zbrozek AS, Dukes EM. The validity and reproducibility of a work productivity and activity impairment instrument. *Pharmacoeconomics*. 1993;4(5):353-65. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/10146874>
12. McLean S, Chandler D, Nurmaov U, Liu J, Pagliari C, Car J, Sheikh A. Telehealthcare for asthma: a Cochrane review. *CMAJ*. 2011;183:E733-742. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/21746825>.
13. van Gaalen JL, Beerthuizen T, van der Meer V, van Reisen P, Redelijkheid GW, Snoeck-Stroband JB, Sont JK, SMASHING study group long-term outcomes of Internet-based self-management support in adults with asthma: randomized controlled trial. *J Med Internet Res* 2013;15(9):e188
14. Global Initiative for Asthma. 2016 GINA Report, Global Strategy for Asthma Management and Prevention [Internet]. Washington (DC), Geneva (Switzerland): Global Initiative for Asthma; 2016. Available from: <http://ginasthma.org/2016-gina-report-global-strategy-for-asthma-management-and-prevention/>. Accessed November 2, 2016.
15. Morrison D, Mair FS, Yardley L, Kirby S, Thomas M. Living with asthma and chronic obstructive airways disease: using technology to support self-management – an overview. *Chron Respir Dis*. 2016 Aug 10; pii: 1479972316660977 [Epub ahead of print]. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/27512084>.

Table 1 – Baseline Characteristics of Subjects Who Completed the Study

Measure ^a	Result ^b
N	40
Female	30 (75.0%)
Age, years	50 (21, 78)
Age of asthma diagnosis, years	22 (0, 67)
Race	
African American	25 (65.0%)
Caucasian	13 (32.5%)
American Indian or Alaska native	1 (2.5%)
Asian	1 (2.5%)
Ethnicity	
Hispanic or Latino	0 (0%)
Weight, kg.	97.3 (54.5, 160)
Asthma severity (per physician)	n = 40
Mild	13 (32.5%)
Moderate	18 (45.0%)
Severe	9 (22.5%)
High school education or less	20 (50%)
Night symptoms	23 (57.5%)
Needs help reading hospital materials	
Always	1 (2.5%)
Sometimes	6 (15.0%)
Occasionally	2 (5.0%)
Never	31 (77.5%)

Smoking history	n = 40
Never	25 (62.5%)
Current	6 (15.0%)
Former	9 (22.5%)
Most frequent (>20%) comorbidities	
Allergic rhinitis or hay fever	26 (65.0%)
Chronic sinusitis	14 (35.0%)
Depression	13 (32.5%)
Diabetes mellitus	8/39 (20.5%)
GERD	13 (32.5%)
Hypertension	15 (37.5%)
Morbid obesity (BMI > 35)	20 (50.0%)
Positive allergy test history	12 (30.0%)
Sleep disorders	16 (40.0%)

a. kg – kilograms; GERD, gastroesophageal reflux disease, BMI – body mass index)

b. Data presented as median (minimum, maximum) for continuous variables and as N (%) or n/N (%) for categorical variables.

Table 2 – Outcome measures at baseline compared to end of 12-week study

Measure ^a	Baseline ^b	End of Study ^b	Change ^b	P-value
ACT score	15.05 (5.03)	16.73 (5.21)	1.68 (4.0) ^c	0.011 ^d
ASUI score	0.64 (0.23)	0.73 (0.24)	0.095 (0.2) ^c	0.019 ^d
BMI (kg/m ²)	34.91 (8.99)	33.8 (9.76)	-1.17 (4.2)	0.056
Weight (kg)	97.25 (22.78)	93.04(26.6)	-4.22 (13.3)	0.034 ^d
PROMIS Mental status	13.23 (3.68)	14.77 (3.9)	1.55 2.4)	0.010 ^d
PROMIS Physical status	13.48 (3.71)	13.95 (3.98)	0.48 (1.9)	0.487
FEV ₁ (L)	2.28 (0.75)	2.3 (0.78)	0.022 (0.3)	0.530
Peak expiratory flow (L/min)	388.57 ± 109.9	403.1 ± 101.38	14.52 ± 49.8	0.197
FEV ₁ /FVC	0.77 (0.11)	0.76 (0.12)	0.005 (0.1)	0.994
Number of nightly asthma symptoms in last month	5.59 (8.67)	5.7 (8.55)	-0.55 (7.9)	0.906
Rescue albuterol use in last week	3.03 (1.23)	3.15 (1.23)	-0.125 (1.1)	0.501
WPAI – Amount work productivity affected in last 7 days	1.53 (2.36)	0.71 (1.23)	-0.5 (1.0)	0.188
WPAI – Activity level	4.35 (3.36)	3.65 (3.42)	-0.7 (2.8)	0.069
WPAI – Work hours missed in last week because of asthma	1.73 (6.18)	0 (0)	-2.36 (7.2)	0.500
Asthma flare frequency requiring ER or hospital in last 3 months	0.3 (0.61)	0.37 (1.04)	0.07 (0.9)	1.000
Worsening asthma flares/attacks not requiring an acute care visit	3.21 (5.74)	1.25 (1.65)	-1.96 (6.0)	0.028 ^d

a. ACT – Asthma Control Test; ASUI – Asthma Symptom Utility Index; WPAI – Work Productivity and Activity Index; BMI – body mass index; kg – kilograms; ER – emergency room; FEV₁ forced expiratory volume in 1 second; FVC – forced vital capacity)

- b. Values expressed as mean $\pm$ standard deviation.
- c. Minimum clinical significance criteria (ACT change $\leq$ -4 and ASUI change $\geq$ 0.09).
- d. Using a threshold of $P \leq 0.050$, we determined these changes to be statistically significant.