

The efficacy of a mobile phone application to improve adherence to treatment and self-management in people with chronic respiratory disease in Romanian population – a pilot study

Laura Adela Munteanu

Universitatea de Medicina si Farmacie Victor Babes din Timisoara

Mirela Frandes (✉ mirela.frandes@umft.ro)

Universitatea de Medicina si Farmacie Victor Babes din Timisoara <https://orcid.org/0000-0002-5249-6859>

Bogdan Timar

Universitatea de Medicina si Farmacie Victor Babes din Timisoara

Emanuela Tudorache

Universitatea de Medicina si Farmacie Victor Babes din Timisoara

Ariadna Petronela Fildan

Universitatea Ovidius din Constanta Facultatea de Medicina

Cristian Oancea

Universitatea de Medicina si Farmacie Victor Babes din Timisoara

Doina Ecaterina Tofolean

Universitatea Ovidius din Constanta Facultatea de Medicina

Research article

Keywords: asthma, m-health, quality of life, chronic disease, exacerbation

Posted Date: December 5th, 2019

DOI: <https://doi.org/10.21203/rs.2.18256/v1>

License:  This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Version of Record: A version of this preprint was published at BMC Health Services Research on May 27th, 2020. See the published version at <https://doi.org/10.1186/s12913-020-05340-0>.

Abstract

Background Many studies assessed the effect of mobile phone applications on self-management outcomes in patients with asthma but all of them presented different results. In this paper we examined the effect of a mobile phone application on self-management and disease control in Romanian population.

Material and methods This study included 93 patients diagnosed with asthma that were recalled every three months for a year for assessment and treatment. Patients were divided into two groups. The first group included patients that received treatment and the second group received treatment and also used the smartphone application. Number of exacerbations and asthma control test (ACT) were recorded.

Results ACT score was significantly higher for patients using also the mobile application than for the patients using the treatment alone, Mann-Whitney U test, $p < 0.001$. When considering the exacerbations rate, the patients not using the application presented an insignificant lower number of exacerbations than the group using the application, 40.74% vs. 58.97%, respectively, chi-square test, $X^2(1) = 3.105$, $p = 0.081$. The number of exacerbations without hospitalization was significantly higher in case of the first group, when comparing to the second group, 46.3% vs 10.26%, $X^2(1) = 13.71$, $p < 0.001$.

Conclusion Our study indicates that smartphone applications are an effective way to improve asthma control and self-management when used continually in our population. We found significant positive effects in disease control and exacerbation frequency.

Background

Asthma is a chronic respiratory disease that affects more than 334 million people of all ages in all parts of the world. It is estimated that the number of patients suffering of asthma will increase by 100 million more until 2025.(1)

Although there are many evidence-based guidelines and effective treatments for this disease, many patients with asthma still have uncontrolled symptoms. Guidelines define poor control of the disease as having daytime symptoms, the need to use short-acting inhaler more than twice weekly, having reduced activities due to asthma or having to wake up due to the respiratory symptoms.(1)

There is significant evidence for the effectiveness of self-management in asthma but there are important challenges implementing this support. These obstacles appear due to the patients lack of knowledge and training regarding the disease and inhaler technique and due to the healthcare provider's lack of time, skill or motivation to support self-management in patients.(2) (3)

Over the last three decades important improvements have been made regarding the adherence to treatment in patients with asthma with the help of the Internet and other electronic modalities.(4) (5)

In the late 90`s the concept of electronic management of health (e-health) appeared, defining an area at the intersection of public health, medical informatics and business with the objective to improve and deliver medical information and services.(6)

There are two modalities by which healthcare can be provided with the help of technology. The first one is Tele-health which means providing healthcare “at a distance” and “digital interventions” which means delivering healthcare by web-based interventions on PC or mobile devices, applications on smartphone, etc.(7)

A recent research found that the key components to improve asthma outcome with the help of mobile devices are: information and self-care education, self-monitoring, asthma action plans, feedback from devices, alerts and messages to patients and daily use availability.(5)

Estimates show that by 2019 more than a billion people will use m-Health apps on their smartphones.(8)

Due to the fact that these m-Health applications are an easy way to communicate information, share experiences and are low cost and easily available, they can have the potential to improve self-management in patients with asthma.(9) (10)

Many studies assessed the effects of m-Health applications on self-management outcomes in patients with asthma, but all of them presented different results.(11) (12) (13) (14)

Some of them demonstrated that m-Health applications can improve pulmonary function, asthma symptoms, quality of life, reduce the rate of exacerbations,(15) and others found no significant impact on the above mentioned parameters.(14)

Although a meta-analysis questioned the evidence behind the effectiveness of telemedicine interventions in asthma,(16) a recent systemic review conducted on digital interventions for asthma presented promising conclusions.(5)

In a study that evaluated the predictors of uncontrolled bronchial asthma, 58% of the studied patients were found with exacerbations due to different reasons.(17)

The conclusions of the last Romanian awareness campaign on the World Asthma Day showed that treating asthma is deficitary, just 13.5% of the studied patients known as diagnosed with asthma being actually treated.(18)

Although nowadays there are many mobile phone applications designed to improve healthcare, there are no specially designed applications for asthma patients in Romania. In Romania asthma remains underdiagnosed and, in many cases, poorly treated thus the objective of this paper was to observe the effect of a mobile phone application on self-management and disease control in Romanian population.

Methods

Design

All the subjects have been informed upon the research, and written informed consent was obtained before the beginning of the study. This research was respecting the Declaration of Helsinki ethical principles for research regarding the safety of human subjects. The study design and contract forms were approved by the Ethics Committee of the “Victor Babes” hospital (nr.8068/20/09/2018).

We included patients meeting the criteria of the Global Initiative for Asthma (GINA) guidelines (history of characteristic symptom patterns and variable airflow limitation $FEV_1/FVC < 0.7$ and FEV_1 increases by > 200 mL and $> 12\%$ of the baseline value) (1) who were unable to control the condition although they received proper treatment and age > 18 years (this was considered the first evaluation = T1).

Exclusion criteria were: illiteracy, cognitive impairment, no knowledge how to properly use a smartphone.

According to our study design, at the T1 visit (which we considered the baseline value), patients were evaluated and trained regarding the inhalation technique. The patients were divided into two groups. The separation was made according to the will of the patient to use the application and availability or not of a smartphone. The first group included 54 patients that received only pharmacological treatment and the second group that consisted out of 39 patients received treatment and used the smartphone application. The mobile phone application reminded daily the patients to use the prescribed medication and to complete the specific questionnaire. A graph was daily created by the program once the patients introduced the values and the physician could observe the results in real time. We excluded from the study the patients that did not access the application when reminded and did not follow the instructions (in total 12 patients were excluded).

Measures and instruments

The included patients were afterwards recalled every three months for one year for assessment and treatment (T2 to T5). Number of exacerbations and asthma control test were recorded. Patients completed every recall the asthma control test questionnaire (ACT) which is used to assess the symptoms. This questionnaire is a patient self-administered tool for identifying those with poorly controlled asthma. Its score ranges from 5–25 (the higher score the better). Scores ranging 20–25 are classified as well-controlled, scores from 16–19 represent not well controlled and 5–15 as very poorly controlled. The minimally important difference is 3 points between two groups.(1)

Exacerbations are defined as acute episodes, which are characterized by progressive increase in one or more typical asthma symptoms (dyspnea, cough, wheezing and chest tightness) accompanied by a decrease in expiratory flow. (1)

Pneumocontrol (Fig. 1–4) is an application developed by a group of medical physicians together with an IT specialist. The application was developed for the self-management of the patients with asthma and chronic obstructive pulmonary disease (COPD).

Depending on the diagnosis (asthma or COPD) patients will complete a questionnaire (Asthma control test - ACT or COPD assessment test – CAT). The score will allow a presumptive patient classification and will display messages of: normal evolution (continue treatment), alarming evolution (need for medical consultation) and immediate medical emergencies. Medical values are processed automatically, and a graphical score will indicate patient classification according to medical standards and disease control level. The mobile application allows patient identification through a user account. Patient monitoring involves the introduction of the attending physician. Furthermore, it will save the patients history, the number of completed forms and the evolution of the scores from the questionnaires.

The application has three specific areas: self-management plan with specific questionnaires, inhalation devices techniques with video presentation and pulmonary rehabilitation exercises with video explanation and subtitles.

Statistical analysis

Measured data were described as mean (standard deviation) for numerical continuous variables with Gaussian distribution, median (percentile 25% - percentile 75%) for numerical variables without Gaussian distribution, or absolute frequency (percentage) for categorical variables. Continuous variable distributions were tested for normality using the Shapiro–Wilk’s test and for equality of variances by using Levene’s test.

The significance of the differences between groups was assessed using the Student’s t-test (means, Gaussian populations), Mann–Whitney U test (medians, non-Gaussian populations) or Kruskal-Wallis test (medians, non-Gaussian populations), and Pearson chi-square or Fisher’s exact test (proportions) were used.

Data were analyzed using the SPSS v.17 software (SPSS Inc., Chicago, IL, USA). The graphical representations were generated using GraphPad Prism v8.0.2. A P-value of 0.05 was considered as the threshold for statistical significance, and a confidence level of 0.95 was considered for estimating intervals.

Results

The first group of asthma patients, who received only treatment, without using the smartphone application, included 54 patients, 30 males and 24 females, aged between 18 and 72 years, mean age 38.59 (\pm 17.64) years, 95% CI (33.78; 43.41).

At the first evaluation (T1), most of these patients (85.18%) used an emergency inhaler. In addition, almost a half of the patients (40.74%) presented severe exacerbations which required hospitalization, while 35.18% of the patients presented mild to moderate exacerbations, without hospitalization. The median ACT score, at the first evaluation, was 18.00 (17.00–19.00).

At the second evaluation (T₂), slightly lesser patients (74.07%) used the emergency inhaler. No patient presented severe exacerbations requiring hospitalization, while more patients presented mild to moderate exacerbations (46.3%). The ACT score has significantly improved to 19.00 (17.00–19.00) comparing to the initial evaluation, Mann-Whitney U test, $p < 0.001$. At the third evaluation, the number of inhalers used has reduced to 38.88%, while the ACT score presented significantly higher values than the previous evaluation, 20.00 (20.00–22.00), Mann-Whitney U test, $p < 0.001$. On the contrary, when considering the evaluations at 9 (T₄) and 12 months (T₅), we observed that the ACT score did not significantly improved when comparing to the previous evaluations, Mann-Whitney U test, $p = 0.188$, and, Mann-Whitney U test, $p = 0.764$, respectively, but the number of patients hospitalized for severe exacerbation at T₅ was higher. The complete description of the results observed at the evaluations of the first group is presented in Table 1.

Table 1

Description of the results observed at the evaluation of the asthma patients included in the first group (N = 54).

Evaluation time	ACT score ^(a)	Emergency inhaler used ^(b)	Exacerbations ^(b)	
			Required hospitalization	Did not require hospitalization
T ₁	18.00 (17.00–19.00)	46 (85.18%)	22 (40.74%)	19 (35.18%)
T ₂	19.00 (19.00–20.00)	40 (74.07%)	0 (0%)	25 (46.3%)
T ₃	20.00 (20.00–22.00)	21 (38.88%)	1 (1.85%)	7 (12.96%)
T ₄	21.00 (20.00–22.00)	14 (25.92)	1 (1.85%)	8 (14.81%)
T ₅	21.00 (20.00–22.00)	17 (31.48%)	5 (9.26%)	8 (14.81%)
Abbreviations: T ₁ = initial evaluation time, T ₂ = evaluation at 3 months; T ₃ = evaluation at 6 months; T ₄ = evaluation at 9 months; T ₅ = evaluation at 12 months. ACT = Asthma Control Test.				
(a) Values are presented as median (percentile 25% - percentile 75%).				
(b) Values are presented as absolute frequency (percentage).				

The second group of asthma patients who used the mobile application in addition to their treatment, included 21 male and 18 female patients, aged between 18 and 66 years, mean age 36.87 (± 15.44) years, 95% CI (31.87; 41.88).

At the first evaluation (T1), all the patients used an emergency inhaler. More than a half of the patients (58.97%) presented severe exacerbations requiring hospitalization, while 41.03% of the patients presented exacerbations which did not require hospitalization. The median ACT score was 19.00 (18.00–20.00).

When considering the second evaluation (T2), only 23.08% of the patients (23.08%) were still using an emergency inhaler. In addition, we observed that no patient presented exacerbations requiring hospitalization, while also lesser patients presented mild to moderate exacerbations (10.26%). The ACT score has significantly improved to 21.00 (20.00–22.00) comparing to the initial evaluation, Mann-Whitney U test, $p < 0.001$. At the third evaluation, the number of inhalers used was significantly reduced while the ACT score presented significantly higher values than the previous evaluation, mean score 23 (23.00–24.00), Mann-Whitney U test, $p < 0.001$. At the evaluations at 9 and 12 months, the ACT score maintained the same value as in T3 and there was no severe exacerbation. The complete description of the results observed at the evaluation of the second group is presented in Table 2.

Table 2

Description of the results observed at the evaluation of the second group (N = 39).

Evaluation time	ACT score ^(a)	Emergency inhaler used ^(b)	Exacerbations ^(b)	
			Required hospitalization	Did not require hospitalization
T ₁	19.00 (18.00–20.00)	39 (100%)	23 (58.97%)	16 (41.03%)
T ₂	21.00 (20.00–22.00)	9 (23.08%)	0 (0%)	4 (10.26%)
T ₃	23.00 (23.00–24.00)	4 (10.26%)	0 (0%)	5 (12.82%)
T ₄	23.00 (23.00–24.00)	1 (2.56%)	0 (0%)	1 (2.56%)
T ₅	23.00 (23.00–24.00)	4 (10.26%)	0 (0%)	4 (10.25%)
Abbreviations: T ₁ = initial evaluation time, T ₂ = evaluation at 3 months; T ₃ = evaluation at 6 months; T ₄ = evaluation at 9 months; T ₅ = evaluation at 12 months. ACT = Asthma Control Test.				
(a) Values are presented as median (percentile 25% - percentile 75%).				
(b) Values are presented as absolute frequency (percentage).				

When comparing the results observed between the two groups, at the first evaluation, there were no significant differences of the ACT score, Mann-Whitney U test, $p = 0.495$. On the contrary, at T₂ the ACT score was significantly higher for patients that used the mobile application in addition to treatment than for the patients using the treatment alone, Mann-Whitney U test, $p < 0.001$. Similarly, the same significant difference of ACT score was maintained between the two groups when considering the evaluations at 6 months (T₃), 9 months (T₄), and 12 months (T₅) (Fig. 5).

Figure 5. The ACT score of the group using the only treatment (Group 1) and the group using both the treatment and mobile application (Group 2). (T₁ = initial evaluation time, T₂ = evaluation at 3 months; T₃ = evaluation at 6 months; T₄ = evaluation at 9 months; T₅ = evaluation at 12 months. ACT = Asthma Control Test).

At the same time, we observed significant differences between the ACT score of the group using the treatment and mobile application and the group using only the treatment stratified by gender.

Regarding the exacerbation rate, at the first evaluation, a higher proportion of patients not using the application presented exacerbations compared with the group using the application, irrespective of hospitalization requiring (58.97% vs 40.74%, chi-square test, $X^2(1) = 3.105$, $p = 0.081$, for severe exacerbation; 41.03% vs 35.18%, chi-square test, $X^2(1) = 0.329$, $p = 0.566$, for mild to moderate exacerbation). In addition, at the second evaluation, we did not observe exacerbations requiring hospitalization in any of the two groups, while the number of exacerbations which did not require hospitalization was significantly higher in case of the first group, when comparing to the second group, 46.3% vs 10.26%, $X^2(1) = 13.71$, $p < 0.001$.

Moreover, at the third evaluation, we observed one exacerbation requiring hospitalization in the first group and still zero in the second group, while the number of exacerbations which did not require hospitalization was the same in both groups. When considering the other evaluations, we observed that the number of exacerbations without requiring hospitalization was significantly lower in case of the second group for the fourth and insignificantly lower for the fifth evaluations, 14.81% vs. 2.56% (Fisher exact test, $p = 0.04$) and 14.81% vs 10.25% (Fisher exact test, $p = 0.748$), respectively. The number of exacerbations requiring hospitalization was still zero in the second group, while in the first group we observed a significant higher number of exacerbations for the fifth evaluation, 9.26% (Fisher exact test, $p = 0.031$).

Discussion

In this study we analyzed if a mobile application specially designed for patients with asthma in Romanian population can improve self-management and disease control.

Although in the last years many studies have been published regarding the feasibility and importance of providing self-management and control in patients with asthma, there are a large number of studies that found no significant improvement regarding symptoms and asthma control after using m-health applications.(19)(20)(21)(22)

The present study showed that self-management has been improved and exacerbation rate has been significantly reduced after 3 months of using the specific mobile phone application compared to the group that did not used the application. Our findings could be explained by the fact that those who used the application had videos to remind them the correct inhalation technique; pulmonary rehabilitation exercises and action plans.

A recent systematic review that analyzed patient self-management of asthma using mobile applications found that from the researched papers, 90% were indicative of significant impact on most outcomes evaluated (23), and just one paper did not find a positive impact on the assessed outcomes.(15)

Another study that analyzed the impact of a mobile application on health outcomes in patients with asthma found that the patients that used the application achieved a well-controlled asthma score (49%) (ACT > 19) compared to the control group (27%), values that were statistically significant. Furthermore,

patients using the application improved their ACT score by 6 points, whereas the control group had an improvement by only 2 points (median). (13).

Compared to these results, ACT improvements were lower in our study. However, both groups improved their scores over the one-year study period. Participants using the application showed the highest ACT scores. Moreover, we observed that the mean score of the group that used the mobile phone application significantly improved when comparing with the initial evaluation.

We also observed that after the third evaluation, although patients did not reach the maximum ACT score, no more significant improvements were registered in both groups.

Cook et al. observed that a minimally proactive use of a mobile application had a significantly improvement in asthma control in patients that previously had uncontrolled asthma. They reached this conclusion in only 4 months. Moreover, the authors emphasized that the use of the application was associated with a statistical and clinical improvement in ACT scores. (11) Results demonstrated an increase of 3 points in the mean ACT score after only 5 weeks of application use. The patients with uncontrolled asthma (an ACT score under 20 points) benefited the most, with a mean increase of 5.7 points.(11)

Although it has been suggested that self-management effectiveness is reduced when assessed over long-term follow-up (24), this study showed that patients had a good compliance and asthma control has been improved in a period over one year. A possible explanation for this situation could be the fact that the patients knew they were in a study and that they had to come for re-evaluation every three months, while in the study of Kauppinen et al, the patients were assessed for a much longer period (> 10 years).

A study that evaluated web-based asthma self-management found that emergency rooms or acute visits to the physician for asthma symptoms did not significantly change in the studied group.(25) Compared with this study we found that the use of action plans from the application and the step up self-medication recommended by the device, had a significant impact on the physician and emergency room visits.

Two studies analyzed the impact of mobile phone based self-management on unscheduled visits to the emergency department and hospital admissions due to asthma-related complications. (14)(15) While one study showed that the patients that used the mobile phone application had a reduced attendance to the emergency department compared to the control group another study found no significant outcomes regarding the emergency department visits. (15)

Regarding the hospital admissions, the results of both authors were statistically non-significant. In the present study, we observed a significant reduction in hospital admission for the group using the application, more exactly, starting from the second evaluation, there were no exacerbations requiring hospitalization. When considering the exacerbations that did not require hospitalization, we observed

significantly lower numbers in the group using the application for the second, third and fourth evaluations.

A limitation of this study could be the reduced sample size. Another limitation is that compared to other studies that included younger or older patients, we assessed patients over 18 years, with a mean age of 38.59 (± 17.64) years, at this age it can be considered that the patients are more likely to use self-management applications especially, due to the awareness of the disease. This application was designed especially for the Romanian population and is restricted to this area thus the application cannot be used in other countries.

Conclusion

Our study indicates that smartphone applications are an effective way to improve asthma control and self-management when used continually in our population. We found significant positive effects in disease control and exacerbation frequency. Pneumocontrol is a potential application that can be useful in order to improve asthma outcomes in our population.

Abbreviations

GINA - Global Initiative for Asthma

FEV₁ – Forced Expiratory Volume

FVC – Forced Vital Capacity

ACT – Asthma Control Test

COPD – Chronic Obstructive Pulmonary Disease

Declarations

Competing interests

The authors declare no conflict of interest.

Funding

No funding was received for this work.

Acknowledgments

Not applicable

Availability of data and materials: The authors confirm that all data underlying the findings are fully available without restriction. Since the database with the analyzed data contains personal patients' information, the data will be available for all interested researchers after submitting a request to the ethics committee of the hospital.

Authors' Contributions: MLA, TE, FAP conceived of the presented idea, OC, TDE wrote the manuscript with support from MLA, TE, TB and FM, FM performed the calculations. All authors discussed the results and contributed to the final manuscript.

Ethics Approval and Consent to Participate

All the subjects have been informed upon the research, and written informed consent was obtained before the beginning of the study. This research was respecting the Declaration of Helsinki ethical principles for research regarding the safety of human subjects. The study design and contract forms were approved by the Ethics Committee of the "Victor Babes" hospital (nr.8068/20/09/2018).

References

1. GINA. Global Initiative for Asthma. Global Strategy for Asthma Management and Prevention. www.ginasthma.org [Internet]. 2018;1–160. Available from: <http://search.ebscohost.com/login.aspx?direct=true&db=cin20&AN=118972966&site=ehost-live>
2. Craig P, Dieppe P, Macintyre S, Michie S, Nazareth I, Petticrew M, et al. Developing and evaluating complex interventions: the new Medical Research Council guidance. *BMJ* [Internet]. 2008 Sep 29;337:a1655–a1655. Available from: <https://www.ncbi.nlm.nih.gov/pubmed/18824488>
3. Pinnock H, Epiphaniou E, Taylor SJC. Phase IV implementation studies. The forgotten finale to the complex intervention methodology framework. *Ann Am Thorac Soc*. 2014 Feb;11 Suppl 2:S118-22.
4. Krishna S, Francisco BD, Balas EA, Konig P, Graff GR, Madsen RW. Internet-enabled interactive multimedia asthma education program: a randomized trial. *Pediatrics*. 2003 Mar;111(3):503–10.
5. Morrison D, Chb MB, Wyke S, Agur K, Cameron EJ, Chb MB. Digital Asthma Self-Management Interventions: A Systematic Review Corresponding Author: 2014;16.
6. Oh H, Rizo C, Enkin M, Jadad A, Building RFE, Street E. What Is eHealth (3): A Systematic Review of Published Definitions Corresponding Author: 2005;7(3):1–12.
7. Mclean G, Band R, Saunderson K, Hanlon P, Murray E, Little P, et al. Digital interventions to promote self-management in adults with hypertension systematic review and meta-analysis. 2016;34(4).
8. Milosevic M, Milenkovic A, Jovanov E. mHealth @ UAH: computing infrastructure for mobile health and wellness monitoring. Vol. 20, *XRDS: Crossroads, The ACM Magazine for Students*. 2013. 43–49 p.
9. Js MB, Huckvale K, Greenfield G, Car J, Lh G. Smartphone and tablet self management apps for asthma (Review). 2013;(11).

10. Hollenbach JP, Cushing A, Melvin E, McGowan B, Cloutier MM, Manice M. Understanding clinicians' attitudes toward a mobile health strategy to childhood asthma management: A qualitative study. *J Asthma* [Internet]. 2017;54(7):754–60. Available from: <https://doi.org/10.1080/02770903.2016.1263649>
11. Cook KA, Modena BD, Simon RA. Improvement in Asthma Control Using a Minimally Burdensome and Proactive Smartphone Application. *J allergy Clin Immunol Pract*. 2016;4(4):730-737.e1.
12. Zairina E, Abramson MJ, McDonald CF, Li J, Dharmasiri T, Stewart K, et al. Telehealth to improve asthma control in pregnancy: A randomized controlled trial. *Respirology*. 2016 Jul;21(5):867–74.
13. Cingi C, Yorgancioglu A, Cingi CC, Oguzulgen K, Muluk NB, Ulusoy S, et al. The “physician on call patient engagement trial” (POPET): measuring the impact of a mobile patient engagement application on health outcomes and quality of life in allergic rhinitis and asthma patients. *Int Forum Allergy Rhinol* [Internet]. 2015 Jun 1;5(6):487–97. Available from: <https://doi.org/10.1002/alr.21468>
14. Liu W-T, Huang C-D, Wang C-H, Lee K-Y, Lin S-M, Kuo H-P. A mobile telephone-based interactive self-care system improves asthma control. *Eur Respir J*. 2011 Feb;37(2):310–7.
15. Ryan D, Price D, Musgrave SD, Malhotra S, Lee AJ, Ayansina D, et al. Clinical and cost effectiveness of mobile phone supported self monitoring of asthma: Multicentre randomised controlled trial. *BMJ*. 2012;344(7854):1–15.
16. Zhao J, Zhai Y-K, Zhu W-J, Sun D-X. Effectiveness of Telemedicine for Controlling Asthma Symptoms: A Systematic Review and Meta-analysis. *Telemed J E Health*. 2015 Jun;21(6):484–92.
17. Marincu I, Frenț S, Mirela T, Mihaicuta S. Rates and predictors of uncontrolled bronchial asthma in elderly patients from western Romania. *Clin Interv Aging*. 2015 Jun 16;10:963–7.
18. Nedelcu R, Mihaltan F. Romanian Awareness Campaign on the World Asthma Day. *Chest* [Internet]. 2016 Oct 1;150(4):3A. Available from: <https://doi.org/10.1016/j.chest.2016.08.006>
19. Guendelman S, Meade K, Benson M, Chen YQ, Samuels S. Improving asthma outcomes and self-management behaviors of inner-city children: a randomized trial of the Health Buddy interactive device and an asthma diary. *Arch Pediatr Adolesc Med*. 2002 Feb;156(2):114–20.
20. Shames RS, Sharek P, Mayer M, Robinson TN, Hoyte EG, Gonzalez-Hensley F, et al. Effectiveness of a multicomponent self-management program in at-risk, school-aged children with asthma. *Ann Allergy Asthma Immunol*. 2004 Jun;92(6):611–8.
21. Sundberg R. Quality of life, school performance, treatment adherence and gender differences in asthma.
22. Rascu A, Elena Popa D, Arghir O, Otelea M. Effects of corticosteroid treatment on respiratory muscles function in patients with severe obstructive lung disease. Vol. 64, *Farmacia*. 2016. 819–822 p.
23. Nabovati E, Sharif R, Farzandipour M, Anvari S, Arani M. Patient Self-Management of Asthma Using Mobile Health Applications: A Systematic Review of the Functionalities and Effects. *Appl Clin Inform*. 2018;08(04):1068–81.
24. Kauppinen RS, Vilkkä V, Hedman J, Sintonen H. Ten-year follow-up of early intensive self-management guidance in newly diagnosed patients with asthma. *J Asthma*. 2011 Nov;48(9):945–

51.

25. Wiecha JM, Adams WG, Rybin D, Rizzodepaoli M, Keller J, Clay JM. Evaluation of a web-based asthma self-management system: A randomised controlled pilot trial. *BMC Pulm Med.* 2015;15(1):1–10.