



# Health-related quality of life in Canadians with asthma: A case-control study using census data



Amy Chen<sup>a</sup>, Behdin Nowrouzi-Kia<sup>b,c,d</sup>, Koyo Usuba<sup>e,f,\*</sup>

<sup>a</sup> School of Health Science, Hibernia College, Dublin, Ireland

<sup>b</sup> Centre for Research in Occupational Safety and Health, Laurentian University, Sudbury, Ontario, Canada

<sup>c</sup> School of Rural and Northern Health, Laurentian University, Canada

<sup>d</sup> Department of Occupational Therapy and Occupational Science, University of Toronto, Ontario, Canada

<sup>e</sup> Research Centre for Evaluating Children's Health Outcomes (ECHO), Laurentian University, Sudbury, Ontario, Canada

<sup>f</sup> Child Health Evaluative Sciences, Hospital for Sick Children, Toronto, Ontario, Canada

## ARTICLE INFO

### Keywords:

Quality of life (QOL)

Health-related quality of life (HRQoL)

Asthma

Health utilities index mark 3 (HUI3)

Single-attribute utility (SAU)

Multi-attribute utility (MAU)

Canadian community health survey (CCHS)

## ABSTRACT

**Background:** Asthma is a common medical condition that impacts the lives of many Canadians; yet the health-related quality of life (HRQoL) in persons with asthma relative to the general population (GP) is poorly studied. In this study, data from the Canadian Community Health Survey (CCHS) 2013 was used to quantify and compare the HRQoL of the asthmatic population (AP) and the GP.

**Methods:** A representative survey sample of Canadians was taken from the CCHS to compare the Health Utilities Index Mark 3 (HUI3) scores, a generic HRQoL measure, between the AP (n = 572) and the GP (n = 6518). The HUI3 multi-attribute utility (MAU) and the single-attribute utility (SAU) scores between the two sample groups were studied. The CCHS 2013 dataset was explored as the primary analysis, while the 2012 dataset was used as the confirmatory analysis to verify the consistency of the results.

**Results:** Clinically important difference was found in the MAU score between the AP and GP (p < 0.001, Effect size = 0.30). MANOVA on the eight SAU scores with post-hoc test revealed that the AP had a lower mean score of vision (p < 0.001, Effect size = 0.36) and pain/discomfort (p < 0.001, Effect size = 0.29). Those findings were consistent with the CCHS 2012 dataset result.

**Conclusions:** These results provided evidence that in Canada, having asthma significantly worsens asthma patients' overall HRQoL and imposes significant impacts on the patients' vision and pain/discomfort. Therefore, there is room for improvement in the currently available asthma therapies so patients could achieve better HRQoL; particular focus should be given to the pain/discomfort and vision health domains.

## 1. Introduction

Asthma, characterized by tightness in the chest, coughing, wheezing, shortness of breath, and in more severe cases, the impossibility to breathe due to airway obstruction, is a complex and highly prevalent chronic inflammatory disease of the airways that affects patients of all ages [1]. In Canada, asthma is the third-most common chronic disease [2] and according to Statistics Canada, in 2013, 7.9% of the Canadian population aged 12 and above reported that they have been diagnosed with asthma [3]. Globally, the prevalence of asthma has been on the rise over the last 20 years. The WHO estimated that in 2013, approximately 235 million people suffered from asthma in countries worldwide and approximately 250,000–345,000 death annually are attributable to asthma [4,5]. Current treatments for

asthma involve the prescription of long-term control and short-term relief medicines. Some examples of these medicines include corticosteroids, Cromolyn sodium and nedocromil, immunomodulators (Omalizumab), or beta<sub>2</sub>-adrenoceptor agonists [6,7]. Although a controllable disease, asthma could impose a substantial amount of burden on the society in morbidity, healthcare costs, and patients' quality of life.

Health-Related Quality of Life (HRQoL) is a broad, multi-dimensional concept that encompasses self-derived measurements on the physical, mental, emotion and social functioning aspects of a person's life [8]; and it excludes the economical and spiritual factors that are beyond the scope of healthcare [9]. According to Spilker, focusing on assessing an individual's wellbeing and functioning in each of the three core HRQoL domains (physical, psychological and social) is essential in assessing a person's overall health-related well-being or lack thereof

\* Corresponding author. Research Centre for Evaluating Children's Health Outcomes (ECHO), Laurentian University, 935 Ramsey Lake Road, Sudbury, Ontario, P3E 2C6, Canada.  
E-mail address: [kusuba@laurentian.ca](mailto:kusuba@laurentian.ca) (K. Usuba).

[9]. Thus, HRQoL measures render additional information that could expand our understanding of the extent of the impact of asthma and allow researchers and clinicians to generate a holistic view of how patients truly respond to an interventional therapy as opposed to just assessing a drug's therapeutic effects in a quantitative manner. Despite this, the health-related burden of having asthma is yet unclear as the study on HRQoL in a bigger asthmatic population (AP), in comparison to the general population (GP) at large, is rarely conducted to date.

HRQoL can be measured by Health Utilities Index Mark 3 (HUI3), a generic preference-based multi-attribute measure that is comprised of eight single-attributes (vision, hearing, speech, mobility, dexterity, cognition, emotion, and pain/discomfort) [10]. The advantages of the HUI3 scoring system include: it 1) is designed to collect responses from a wide variety of subjects in the GP and has been used throughout many different nations [10], 2) can be applied to many chronic diseases, 3) determines the overall health profile, which is measured by HUI3 multi-attribute utility (MAU) scores, and 4) measures the HUI3 single-attribute utility (SAU) scores [10,11]. The MAU score is a single-summary score of HRQoL generated using all the required information for each health state defined by the classification system. Whereas, SAU score is a single-attribute score of morbidity for each attribute. It is valuable to determine the SAU scores of morbidity, in addition to measuring the MAU score, as this allows researchers or healthcare providers to gain additional insights into the health status of each health attribute and facilitate the development of additional studies or future healthcare plans to address any health attribute deficits [10]. However, despite of its advantages, HUI3 does not seem to be a popular HRQoL measure used among researchers as there are only a few publications relating to HUI3 scores in the asthmatic populations. Furthermore, for those studies that included HRQoL measures, assessments at its single-attribute level are rarely reported.

To better understand the burden of asthma, it is beneficial to study the HRQoL relationship between the AP and the GP and the use of HUI3 MAU and SAU scores would enable this comparison. The purpose of this study is to examine whether having asthma has any impacts on the HRQoL of the AP compared to GP in Canada and to identify the effect of asthma on each of the HUI3 single-attributes in the AP. This study should be of interest to data analysts, policymakers, researchers, healthcare practitioners, asthma healthcare programs and pharmaceutical industry as the results would be useful in evaluating the effectiveness of currently existing therapies and healthcare programs.

## 2. Materials and methods

This is a case-control study using Canadian census data. The electronic data file from the published Canadian Community Health Survey (CCHS) (year 2013) was obtained from Statistics Canada and used for the analysis in this study. The CCHS is a voluntary, cross-sectional survey that collects information related to the health status, health determinants and health care utilization in a large sample of the Canadian population over the age of 12 living in the ten provinces and three territories, using either computer-assisted personal interview or computer-assisted telephone interview method [3]. The survey represents approximately 98% of the Canadian population and excludes less than 3% Canadian population who reside on reserves and other remote areas, are full time members of the Canadian Forces, and are institutionalized. CCHS used three sampling frames in 2013 to select the sample of households and these are Area frame (40.5% of sample households), Telephone Number frame (58.5%) and Random Digit Dialing sampling frame (1%), thus that a multi-stage stratified cluster sampling design combined with random sampling methods were used to select a sample representing the Canadian population [3,12]. About 65,000 respondents were interviewed for the survey in 2013.

### 2.1. Samples of asthmatic and general population

Our study sample was drawn from the 2013 CCHS dataset. GP sample was the general Canadian population who responded to the CCHS 2013 annual component with the AP sample excluded.

The AP sample was composed of respondents aged 12 and older who have reported that they have been diagnosed of having asthma expected to last or have already lasted six months or more by a healthcare professional at the time of the survey in 2013 [3].

### 2.2. Health-related quality of life measure

The HUI3 was selected in this research as the assessment tool to describe the health status and HRQoL of the AP and GP in Canada. It was selected because it has been proven to be a reliable, responsive and valid measure in providing a comprehensive description of the health status and overall assessment of HRQoL [13]. It describes functional rather than performance health status using eight attributes (vision, hearing, speech, ambulation, dexterity, emotion, cognition and pain/discomfort), each attribute with five or six ordinal levels [10]. The SAU score for each attribute ranges from 0 (most highly impaired) to 1 (not impaired). The MAU score, on the other hand, suggests the overall health status and ranges from  $-0.36$  to  $1$ ; where a negative score indicates health states considered worse than death,  $0$  indicates health states equivalent to death, and  $1$  being the perfect health state [10]. Moreover, Grootendorst *et al.* reported that a difference in mean MAU score of  $0.03$  or more is considered to be clinically important [14].

### 2.3. Statistical analysis

Descriptive statistics was employed to summarize the characteristics of the Canadian AP and GP samples in this study and the MAU and SAU scores were also calculated for both samples. Welch's *t*-test was employed to detect the difference in MAU scores between the AP and GP. Another area of interest was to determine the effect of asthma on the health status of each single-attribute and a Multivariate Analysis of Variance (MANOVA) was employed to detect this. Multivariate significance was tested by Pillai's trace because this test is reported as robust even when some assumptions were not met [15]. If a MANOVA was found to be significant, Least Significant Difference (LSD) post-hoc comparison tests were to be performed to further explore the difference seen in the SAU scores of each single-attribute between the two samples. LSD post hoc analyses were used to protect against increases in Type 1 errors by limiting the number of comparisons that can be made [16]. To aid in interpretation of the effect of having asthma, effect size (ES) was calculated for the MAU and SAU scores using Hedges's *g* [17]. Threshold values recommended by Kazis *et al.* were used to categorize the effect as not significant ( $ES < 0.2$ ), small ( $0.2 \leq ES < 0.5$ ), moderate ( $0.5 \leq ES < 0.8$ ), and large ( $ES \geq 0.8$ ) [18].

### 2.4. Confirmatory analysis

In this study, CCHS data from 2012 was taken and used to conduct a confirmatory analysis to confirm the results obtained from the 2013 CCHS data. The same statistical analyses were performed to confirm whether the results from the 2012 and 2013 dataset were consistent.

## 3. Results

The 2013 CCHS dataset was filtered to exclude missing data and invalid data in which the respondents answered "Don't know", "Refusal", "Not stated". In this study, a total of 7090 valid survey data were used for the analysis. Of those, 572 were categorized as AP group and the rest, 6,518, were categorized as non-asthmatic group or hereafter referred to as GP. Basic demographic information was used to describe the population. Overall, in this community-based population,

**Table 1**  
Demographic characteristics of the Canadian AP and GP samples.

|                                                       | AP                       | GP                       |
|-------------------------------------------------------|--------------------------|--------------------------|
| <b>Sample Size - n</b>                                | 572                      | 6518                     |
| <b>Age - Mean (SD)</b>                                | 57.78 (SD 17.03)         | 58.71 (SD 16.55)         |
| <b>Gender - Female (%)</b>                            | 370 (65%)                | 3038 (47%)               |
| <b>Education - n (%)</b>                              |                          |                          |
| Secondary School Graduate                             | 137 (24%)                | 1164 (18%)               |
| Secondary School Graduate                             | 110 (19%)                | 1415 (22%)               |
| Some post-secondary Education                         | 24 (4%)                  | 215 (3%)                 |
| Post-secondary Certificate                            | 294 (52%)                | 3620 (56%)               |
| <b>Marital Status - n (%)</b>                         |                          |                          |
| Now Married                                           | 265 (46%)                | 3594 (55%)               |
| Common-law                                            | 45 (8%)                  | 424 (7%)                 |
| Widowed                                               | 75 (13%)                 | 848 (14%)                |
| Separated                                             | 27 (5%)                  | 230 (4%)                 |
| Divorced                                              | 63 (11%)                 | 545 (8%)                 |
| Single                                                | 97 (17%)                 | 870 (13%)                |
| <b>Smoking Status: Ever Smoked Daily - n (%)</b>      | 507 (89%)                | 5727 (88%)               |
| <b>Have Insurance Prescription Medication - n (%)</b> | 460 (80%)                | 5256 (81%)               |
| <b>BMI - Mean (SD)</b>                                | 28.70 (SD 6.65)          | 27.35 (SD 5.20)          |
| <b>Total Household Income - Mean (SD)</b>             | 60,442.20 (SD 52,504.00) | 73,794.70 (SD 82,678.37) |

the AP and GP groups in Canada shared similar mean age, smoking status, prescription medication insurance status, and BMI; while some differences were seen in the percentage female, education status, marital status, and mean household income. Details regarding sample demographics can be found in Table 1. Overall, the demographic results indicated that the AP and GP groups had similar characteristics, suggesting minimal effect on HRQoL scores due to demographic differences.

A total of 6735 respondents responded to the HUI3 related questions. The mean and standard deviation (SD) of the HUI3 MAU and SAU scores of the AP and GP groups were determined using the 2013 dataset (Table 2). The MAU score was 0.77 (SD = 0.27) in the AP, while it was 0.83 (SD = 0.21) in the GP. With the difference of the mean MAU score being 0.06, the mean MAU score in the AP group was significantly lower than the GP group, [ $t(593.5) = -5.02$ ,  $p < 0.001$ ] and the difference was deemed clinically important. The ES estimated by Hedges's  $g$  was 0.30, which suggested that having asthma has significant, small effect in the AP. The MANOVA showed that there was a statistically significant difference in the SAU scores between the AP and GP [Pillai's trace = 0.008,  $F(8,6726) = 7.138$ ,  $p < 0.001$ , partial eta square = 0.008, observed power = 1.00]. The post-hoc analysis using LSD revealed that the mean comparison between the AP and GP was statistically significant in the SAU scores of vision ( $p < 0.001$ , ES = 0.36), ambulation ( $p < 0.001$ , ES = 0.23), and pain ( $p < 0.001$ , ES = 0.29) and the ES values suggested having asthma had small effects on these health domains. There was a significant difference in the mean cognition scores between AP and GP ( $p = 0.016$ ), however, the effect of having asthma on cognition was not considered significant (ES = 0.11).

**Table 2**  
Descriptive statistics of AP and GP samples.

|                | AP (n = 537) Mean (SD) | GP (n = 6198) Mean (SD) | Total (n = 6735) Mean (SD) | Effect Size (95%CI)  |
|----------------|------------------------|-------------------------|----------------------------|----------------------|
| HUI_MAU        | 0.767 (SD 0.273)       | 0.832 (SD 0.215)        | 0.827 (SD 0.221)           | 0.300 (0.290–0.300)  |
| HUI_HEAR       | 0.993 (SD 0.033)       | 0.993 (SD 0.032)        | 0.993 (SD 0.032)           | 0.000 (–0.001–0.001) |
| HUI_VISION     | 0.975 (SD 0.039)       | 0.984 (SD 0.022)        | 0.983 (SD 0.024)           | 0.364 (0.363–0.364)  |
| HUI_SPEECH     | 1.000 (SD 0.003)       | 1.000 (SD 0.006)        | 1.000 (SD 0.006)           | 0.000 (0.000–0.000)  |
| HUI_AMBULATION | 0.973 (SD 0.077)       | 0.986 (SD 0.054)        | 0.985 (SD 0.056)           | 0.231 (0.230–0.233)  |
| HUI_DEXTERITY  | 0.999 (SD 0.015)       | 0.999 (SD 0.019)        | 0.999 (SD 0.019)           | 0.000 (0.000–0.000)  |
| HUI_EMOTION    | 0.984 (SD 0.045)       | 0.985 (SD 0.042)        | 0.985 (SD 0.043)           | 0.024 (0.023–0.025)  |
| HUI_COGNITION  | 0.929 (SD 0.104)       | 0.939 (SD 0.093)        | 0.938 (SD 0.094)           | 0.106 (0.104–0.109)  |
| HUI_PAIN       | 0.818 (SD 0.318)       | 0.890 (SD 0.246)        | 0.885 (SD 0.254)           | 0.285 (0.279–0.291)  |

AP, Asthma Population; GP, General Population; HUI, Health Utilities Index; MAU, Multi-attribute utility.

The means of the eight SAU scores between AP and GP are presented in Table 2.

#### 4. Results for confirmatory analysis

In total, 906 data from the CCHS 2012 database were available for confirmatory analysis. Of those, 78 were categorized as AP, and the rest, 828 were categorized as GP. Similar to the results found from the CCHS 2013 dataset, the AP group had an MAU score of 0.74 (SD 0.28) while the GP group had an MAU score of 0.83 (SD 0.22). The difference of the MAU scores between the AP and GP, which was 0.09, was also statistically significant and clinically important [ $t(86.2) = -2.76$ ,  $p = 0.007$ ]. The ES was estimated to be 0.43, which was higher compared to 2013, but still suggesting small effect. Also in line with the results found from the 2013 dataset was that the MANOVA model showed significantly lower mean SAU scores in the AP compared to GP [Pillai's trace = 0.021,  $F(8,897) = 2.402$ ,  $p = 0.014$ , partial eta square = 0.021, observed power = 0.899]. The post-hoc analysis demonstrated that the mean comparison between the AP and GP was statistically significant in the SAU scores of vision ( $p = 0.003$ , ES = 0.35), pain ( $p = 0.001$ , ES = 0.39), and emotion ( $p = 0.005$ , ES = 0.23), which indicated that having asthma had small effects on these health domains.

#### 5. Discussion

Within the context of CCHS that was representative of the Canadian population in 2013, the burden of illness for persons with asthma was quantified using the HUI3 measure in this analysis. Overall, our results indicated that there was a significant difference in the mean HUI3 MAU scores between the AP (HUI\_MAU = 0.77) and GP (HUI\_MAU = 0.83) groups, with the mean MAU score being 0.06 higher in the GP group, where a difference in MAU score of 0.03 or more is considered clinically important.

Comparing the results of this study to earlier published literature, such as the studies done by Mittman *et al.* and McTaggart *et al.* [19,20], our study reported a lower mean MAU score (HUI\_MAU = 0.84 to 0.88 depending on the respondents' age and gender according to Mittman's study; and HUI\_MAU = 0.84 per McTaggart's study). The lower reported MAU scores could be accounted for by the different survey sources. Mittman's study was conducted in the late 1990s using the Canadian National Population Health Survey (NPHS), a longitudinal household survey conducted by Statistics Canada [19]. NPHS was an excellent source of information as it constituted a panel of approximately 17,000 people every two years for up to twenty years. However, it was dated and criticized for its limitation in providing sufficient sample to represent a disease population, particularly for studying special populations such as the seniors, visible minorities, single mothers, users of homecare, shift-workers, individuals with specific chronic conditions and so on [21]. On the other hand, McTaggart *et al.* selected a much smaller regional sample in which the respondents were

English-speaking patients residing in the Vancouver metropolitan area of the Canadian province of British Columbia (BC) only. Furthermore, the respondents were between 19 and 49 years of age; whereas the respondents' mean age in our study was 58, which accounted for the lower HRQoL score associated with increased age [20]. Thus, the results of our study should be regarded as more reliable as the data were collected from a large sample size that well represented the national population.

The significantly lower mean MAU score found in the AP group suggested that having asthma in Canada significantly worsens the overall HRQoL of Canadians, although the estimated ES was small. Moreover, in this study, exploring the differences in the SAU scores between the AP and GP further enabled us to identify the specific health problems associated with asthma. Based on the results of the primary and confirmatory analysis, significantly lower SAU scores were seen in the "Pain" and "Vision" health domains of the AP compared to GP in both 2012 and 2013, indicating that having asthma has caused significant, small effect on pain and vision. The "Pain" health domain of HUI3 refers to the sensation of discomfort and pain that prevents a few to most activities [10]. Given that asthma limits one's physical activities and is associated with many symptoms with the most severe symptom being the impossibility to breathe [1], it is not surprising that clinically significant, lower SAU score in "Pain" was observed. With respect to asthma's effect on vision, although the effect was much smaller than the one in the "Pain" domain, it is worth to be further explored since this has been rarely discussed in the context of asthma. Having asthma itself does not cause vision problems pathologically, this might be linked to the use of inhaled corticosteroids (ICSs) in treating asthma. ICSs are considered the gold-standard, first-line therapy in the effective management and long-term control of mild, moderate or severe persistent asthma [6,7,22]. The use of ICSs has made a positive impact on patient outcomes, however some studies have suggested that the high-dose exposure of ICSs can lead to various systemic side effects such as skin thinning, growth retardation, osteoporosis and ocular problems i.e. glaucoma and cataract [22–24], the latter might explain the lower "Vision" SAU scores seen in this study.

There are a number of disease-specific HRQoL measures, such as Juniper *et al.*'s Standardised Asthma Quality of Life Questionnaire (AQLQ-S) [25], the Living with Asthma Questionnaire (LWAQ) developed by Hyland and colleagues [26], and Marks *et al.*'s Asthma Quality of Life Questionnaire (AQLQ) [27]; of which, the AQLQ-S is most broadly used amongst all asthma HRQoL questionnaires [25,28]. Upon reviewing these questionnaires, it was noted that these disease-specific instruments assess an asthma patient's health state in several domains such as symptoms, activity limitations, psychological/emotional status, social interactions, or exposure to environmental stimuli; however, none of these questionnaires address the concerns around ocular issues asthma patients may experience. It might be because the effect is small or that the ocular problem has not been reported by patients due to its indirect relationship with asthma. Given that HRQoL measure needs to provide a holistic view of the overall health, it might be meaningful to incorporate questions regarding vision issues so that the burden of asthma can be more effectively studied.

On the other hand, although not consistently shown in both 2012 and 2013, significantly lower "Ambulation" and "Emotion" SAU scores in AP were found in 2013 and 2012 respectively. "Ambulation" score, which measures one's ability to walk around [10], was significantly lower in 2013. This could be explained by the activity limitations experienced by asthma patients as a result of having symptoms such as shortness of breath, pain, and discomfort. Furthermore, published evidence have also demonstrated that the loss of bone density and increased risk of fracture are some other adverse effects seen associated with the long-term use of high-dose ICSs, resulting in more inactive life style and severe asthma [22,24,29,30]. "Emotion" health domain measures one's happiness and interest in life [10]. Due to the many symptoms of asthma, expectedly, asthma patients may experience

significant emotional stress compared to the GP. It is recommended that additional studies be performed to confirm the impact of having asthma on patients' ambulation and emotion.

This study also enabled us to compare the burden of asthma with other chronic conditions; although direct comparison needs to be carefully interpreted due to the differences in sample demographics. The HUI3 scores summarized in this study can be used as a benchmark in future studies to compare HUI3 scores obtained from other disease populations.

### 5.1. Limitations

This study allows the use of valuable data collected from a large sample size; however, there are some limitations to studies of this nature. Firstly, HUI3 is a generic HRQoL measure rather than a disease-specific measure and is not specifically designed to be used within a population associated with asthma condition. Therefore, despite that this instrument enabled us to compare the AP and GP groups, it might be perceived by other researchers as less sensitive in detecting specific concerns in persons with asthma. Secondly, the questionnaire responses were obtained via self-report and the responses could be inaccurate and lead to over- or under-reporting of certain medical conditions. Lastly, the CCHS has significant amount of missing data as well as invalid data where respondents had answered "Don't know", "Refusal", and "Not stated" to the variables in this study, which reduced the sample size from 65,000 to 7000. Even though the sample size in this study was fairly large, the results may need to be interpreted with caution.

## 6. Conclusion

Due to the burden of asthma, research on the control and management of asthma is of great importance to Canadians. Based on the results of this study, having asthma significantly worsens asthma patients' overall HRQoL and the difference in the reported HRQoL between the Canadian AP and GP is deemed clinically important. Having asthma also imposes significant impacts on the health domains of vision and pain. The findings from this study provide additional insights into the current state of asthma control and management and highlight avenues of additional study and treatment plan to policy makers, healthcare providers, pharmaceutical companies, asthma healthcare programs and research institutes. There is room for improvement in the currently available asthma therapies to improve patients' HRQoL; particular focus should be given to the pain/discomfort and vision health domains. To effectively study the burden of asthma, it is also recommended that researchers should consider updating existing disease-specific HRQoL questionnaires by incorporating questions related to vision problems to enhance the content validity of such questionnaires.

## References

- [1] Global surveillance, Prevention and Control of Chronic Respiratory Diseases: a Comprehensive Approach, World Health Organization, 2007 Available from: [http://www.who.int/entity/gard/publications/GARD\\_Book\\_2007.pdf?ua=1](http://www.who.int/entity/gard/publications/GARD_Book_2007.pdf?ua=1).
- [2] SEVERE ASTHMA the CANADIAN PATIENT JOURNEY, Asthma Society of Canada, 2014 Available from <https://www.asthma.ca/wp-content/uploads/2017/06/SAstudy.pdf>.
- [3] Statistics Canada, Canadian Community Health Survey, 2013, p. 2013. Available from <http://www.statcan.gc.ca/daily-quotidien/140612/dq140612b-eng.htm>.
- [4] Global Strategy for Asthma Management and Prevention, Global Initiative for Asthma, 2017 Available from <http://ginasthma.org/download/317/>.
- [5] Asthma Fact Sheet, (2017) [cited 2017]. Available from <http://www.who.int/mediacentre/factsheets/fs307/en/>.
- [6] Expert Panel Report 3 (EPR-3), Guidelines for the diagnosis and management of asthma-summary report 2007, J. Allergy Clin. Immunol. 120 (5 Suppl) (2007) S94.
- [7] J.P. Parsons, T.S. Hallstrand, J.G. Mastroradde, D.A. Kaminsky, K.W. Rundell, J.H. Hull, et al., An official American Thoracic Society clinical practice guideline: exercise-induced bronchoconstriction, Am. J. Respir. Crit. Care Med. 187 (9) (2013) 1016–1027.
- [8] Health-related Quality of Life (HRQoL), (2012) [cited 2017]. Available from <http://www.cdc.gov/hrqol/>.

- [9] B. Spilker, *Quality of Life Assessments in Clinical Trials*, Raven Press, 1990.
- [10] J. Horsman, W. Furlong, D. Feeny, G. Torrance, The Health Utilities Index (HUI(R)): concepts, measurement properties and applications, *Health Qual. Life Outcome* 1 (1) (2003) 54.
- [11] F. Mo, B.C. Choi, F.C. Li, J. Merrick, Using Health Utility Index (HUI) for measuring the impact on health-related quality of life (HRQL) among individuals with chronic diseases, *Sci. World J.* 4 (2004) 746–757.
- [12] Yves Beland, *Canadian community health survey, Methodological Overview* (2002) Available from <http://www.statcan.gc.ca/pub/82-003-x/2001003/article/6099-eng.pdf>.
- [13] W.J. Furlong, D.H. Feeny, G.W. Torrance, R.D. Barr, The Health Utilities Index (HUI®) system for assessing health-related quality of life in clinical studies, *Ann. Med.* 33 (5) (2001) 375–384.
- [14] P. Grootendorst, D. Feeny, W. Furlong, Health Utilities Index Mark 3: evidence of construct validity for stroke and arthritis in a population health survey, *Med. Care* 38 (3) (2000) 290–299.
- [15] C.L. Olson, Comparative robustness of six tests in multivariate analysis of variance, *J. Am. Stat. Assoc.* 69 (348) (1974) 894–908.
- [16] C. Stangor, *Research Methods for the Behavioral Sciences*, fourth ed., Wadsworth Cengage Learning, Australia ; Belmont, CA, 2011.
- [17] L.V. Hedges, Distribution theory for Glass's estimator of effect size and related estimators, *J. Educ. Stat.* 6 (2) (1981) 107–128.
- [18] L.E. Kazis, J.J. Anderson, R.F. Meenan, Effect sizes for interpreting changes in health status, *Med. Care* (1989) S178–S189.
- [19] N. Mittmann, K. Trakas, N. Risebrough, B.A. Liu, Utility scores for chronic conditions in a community-dwelling population, *Pharmacoeconomics* 15 (4) (1999) 369–376.
- [20] H.M. McTaggart-Cowan, C.A. Marra, Y. Yang, J.E. Brazier, J.A. Kopec, J.M. FitzGerald, et al., The validity of generic and condition-specific preference-based instruments: the ability to discriminate asthma control status, *Qual. Life Res.* 17 (3) (2008) 453–462.
- [21] Y. Béland, L. Bailie, G. Catlin, M. Singh, CCHS and NPHS—an Improved Health Survey Program at Statistics Canada, (2000).
- [22] R. Dahl, Systemic side effects of inhaled corticosteroids in patients with asthma, *Respir. Med.* 100 (8) (2006) 1307–1317.
- [23] R.G. Cumming, P. Mitchell, S.R. Leeder, Use of inhaled corticosteroids and the risk of cataracts, *N. Engl. J. Med.* 337 (1) (1997) 8–14.
- [24] B.J. Lipworth, Systemic adverse effects of inhaled corticosteroid therapy: a systematic review and meta-analysis, *Arch. Intern. Med.* 159 (9) (1999) 941–955.
- [25] E.F. Juniper, G. Guyatt, R. Epstein, P. Ferrie, R. Jaeschke, T.K. Hiller, Evaluation of impairment of health related quality of life in asthma: development of a questionnaire for use in clinical trials, *Thorax* 47 (2) (1992) 76–83.
- [26] M.E. Hyland, S. Finnis, S. Irvine, A scale for assessing quality of life in adult asthma sufferers, *J. Psychosom. Res.* 35 (1) (1991) 99–110.
- [27] G.B. Marks, S.M. Dunn, A.J. Woolcock, An evaluation of an asthma quality of life questionnaire as a measure of change in adults with asthma, *J. Clin. Epidemiol.* 46 (10) (1993) 1103–1111.
- [28] E.F. Juniper, A.S. Buist, F.M. Cox, P.J. Ferrie, D.R. King, Validation of a standardized version of the asthma quality of life questionnaire, *CHEST J* 115 (5) (1999) 1265–1270.
- [29] C. Chee, L. Sellahewa, J.M. Pappachan, Inhaled corticosteroids and bone health, *Open Respir. Med. J.* 8 (2014) 85.
- [30] M. Eijkemans, M. Mommers, M.T. Jos, C. Thijs, M.H. Prins, Physical activity and asthma: a systematic review and meta-analysis, *PLoS One* 7 (12) (2012) e50775.