Running title: CRS Socioeconomics Study (SoCCoR)
Type of article: Original Contribution

The Socioeconomic Cost of Chronic Rhinosinusitis Study

Miss Nur Wahidah Wahid[1,2] Dr Rupert Smith[1,3], Dr Allan Clark[1], Mr Mahmoud Salam[4], Professor Carl M Philpott[1,5]

[1] *Norwich Medical School, University of East Anglia, Norfolk NR4 7TJ, United Kingdom*
[2] *College of Medicine and Veterinary Medicine, University of Edinburgh, United Kingdom*
[3] *Institute of Naval Medicine, Royal Navy*
[4] *The Ipswich Hospital, Ipswich, United Kingdom*
[5] *James Paget University Hospital NHS Foundation Trust, Gorleston, United Kingdom*

E-mail for correspondence: *C.Philpott@uea.ac.uk*

This study has been reported in accordance with the STROBE statement guidelines for the reporting of observational studies.

Word count = 4804

Abstract

Introduction: Chronic rhinosinusitis (CRS) is highly prevalent, affecting 11% of the population. Studies evaluating the socio-economic impact of CRS are mostly limited to the US population. Currently there is no study that has evaluated the socio-economic costs of CRS in the UK.

Methods: A case-control study of patients with CRS and healthy controls was conducted to investigate the wider socio-economic impact of the disease. Data on demographic and socioeconomic characteristics, out-of-pocket expenditure (OOPE), health resource utilisation, productivity losses and health-related quality of life (HRQoL) via the EQ-5D and SNOT-22 instruments, were collected from questionnaires.

Results: A total of 139 CRS participants and 67 control participants completed the questionnaires. The average total OOPE per patient extrapolated to a 12-month period was £304.84. Other important findings include significantly higher reported primary care interactions (4.14 vs. 1.16, $p<0.001$) as well as secondary care interactions (2.61 vs 0.4, $p<0.001$) in CRS group as compared to controls. The average total missed workdays was estimated to be 18.7 per patient per year. The estimated incremental healthcare cost of CRS per year is £ 16.8 billion or £2.8 billion per million inhabitants. Factors predictive of a higher OOPE include higher household occupancy and income and these accounted for only 9.7% of the total variance in total OOPEs. Other socioeconomic, demographic and HRQoL variables were not found to be predictive factors of OOPE.

Conclusions: This study showed that CRS has a significant wider economic burden beyond the immediate direct healthcare costs. CRS participants had a high level of healthcare service use, OOPE and productivity loss. Results from this study will add to the existing limited data both for the UK and abroad and emphasises the need for effective treatments for these patients to reduce the disease impact.

Key words: Chronic rhinosinusitis, out-of-pocket expenditure, healthcare utilisation

Introduction

Chronic rhinosinusitis (CRS) affects about 11% of the population[1] and whilst the impact of the disease is felt in both primary and secondary care, this has not yet translated to it receiving the same attention as other chronic diseases for research and funding. CRS is one of the most common conditions seen by ENT surgeons as well as by GPs accounting for approximately 15% of ENT outpatient consultations. Primarily a medical disease, much of CRS is managed by GPs with those cases failing medical therapy in the community being referred to secondary care[2]. Recent evidence suggests that compliance with medical treatment and the factors related to that may also add to the burden of CRS management[3-5], with the financial impact identified as a key theme by CRS patients[6].

"Sinusitis" was cited as one of the top-10 most costly physical health conditions to American businesses[7], as it has an increasing incidence in middle age and a subsequent socio-economic impact both to healthcare systems and to economies. The evidence there is suggests the main burden of care in terms of cost falls on the individual (or the family)[8-10], but is derived from an American model of health care and may not accurately reflect the UK National Health Service (NHS) picture. There are no published estimates of cost of health care and productivity losses for patients with CRS in the UK. Recent findings from the USA estimate that patients with CRS spend more than $500 per year on health care and missed an average of 5.67 workdays per year versus 3.74 days per year for patients without CRS[10]. This suggests a significant disease burden on both the health care system and on individuals that is equal to or exceeds diseases that are thought to be more serious. An earlier study by Bhattacharyya found that the overall economic cost was $1539 per patient[8]. Ray et al estimated health care expenditures attributable to CRS and common co-morbidities were $5.78 billion in 1996[11] but did not look at out-of-pocket expenditures or time off work for patients. Also, in the USA, Anand concluded that the costs associated with CRS are higher due to increased clinic visits and prescriptions, as well as significant productivity losses[12]. Surgical treatment for CRS may influence drug costs[13], but this will depend on the level of intervention. UK Hospital Episode Statistics data suggest that approximately 20000 sinus operations are performed each year in England and Wales with a cost of £28 million per year but with 50% of these cases potentially being revision surgeries, there is clearly a long-term burden borne in secondary care[6]. In addition, the outpatient and primary care consultations combined are likely to represent a heavier financial burden.

Objectives

To identify the wider socio-economic costs of CRS to bring about a better understanding of the impact of the disease both to the patient and to the NHS.

Methods

The study was sponsored by the University of East Anglia (UEA) and funded by the Anthony Long and Bernice Bibby Trusts. Ethical approval was granted by the **North of Scotland Research Ethics Committee** (Ref: **13/NS/0045**).

Study Design

The study was conducted as a prospective case-control study. It was opened to recruitment in the East of England in 2013 for a duration of 24 months. Three sites participated including James Paget University Hospital (JPUH), The Ipswich Hospital and the University of East Anglia. Participants were provided with an information leaflet that was also available through patient support group, Fifth Sense (www.fifthsense.org.uk) and the research group website (www.uea.ac.uk/rhinology-group). Participants were given the choice to receive paper questionnaire or electronic questionnaires by email. Questionnaire responses were anonymous with no identification information (name, address/postcode, e-mail or telephone). The information leaflet outlined that consent of study participation would be implied on completion of the anonymised questionnaire. The questionnaires were returned by post in freepost envelopes, scanned into a secure UEA database electronically and further checked for missing data.

Participants and Data Sources

CRS Participants

Inclusion Criteria

Criteria for diagnosis of CRS with or without polyps (EPOS guidelines)[14]

At least two symptoms must be present for at least 12 weeks and include:

- One of either nasal blockage/obstruction/congestion and/or nasal discharge (anterior/posterior nasal drip)
- and either facial pain/pressure and/or reduction or loss of sense of smell and additionally:
- endoscopic signs of: polyps and/or mucopurulent discharge primarily from middle meatus and/or; oedema/mucosal obstruction primarily in middle meatus
- and/or CT changes: mucosal changes within the ostiomeatal complex and/or sinuses

Patients were then classified as having chronic rhinosinusitis without polyps (CRSsNPs), chronic rhinosinusitis with nasal polyps (CRSwNPs) or allergic fungal rhinosinusitis (AFRS); patients with the latter additionally adhered to either the Bent and Kuhn criteria or the modified Vancouver criteria[15].

Healthy Control Participants

Exclusion Criteria

- Prior history of recurrent acute or chronic rhinosinusitis other than having had previous common colds (acute viral rhinosinusitis).
- Any other nose/sinus disorders e.g allergic rhinitis
- Active medical problems that have required a hospital visit within the last 12 months.

Exclusion Criteria for Both Groups

- Patients/controls unable to comprehend written English.
- Patients/controls under the age of 18 years.

Variables and data sources

There were no published questionnaires to assess the socioeconomic impact of CRS but a validated questionnaire by Fox et al[16] measuring the socioeconomic costs of food allergies was adapted[17] and the final study questionnaire was further developed based on literature review, expert input and focus groups (Norfolk Public and Patient Involvement in Research)[18], to allow comparison of data between the CRS group and control group. The questionnaire comprised of two parts; the first part captured information including demographic and socioeconomic information including household occupancy, occupation, highest academic qualification, type of work and work environment (manual/non-manual, outdoor/indoor), and annual household income. The second part of the questionnaire collected information on out-of-pocket expenditure, healthcare service use, missed workdays, as well as an assessment of quality of life and general well-being via the validated 5-level Euroqol 5-Dimension (EQ-5D-5L)[19] preference-based scales and the 22-item Sino-Nasal Outcome Test (SNOT-22)[20]. An EQ-5D index of 1.0 corresponds to full health, whilst the EQ-5D visual analogue scale health score rates perceived health state ranging from 0 ('worst' imaginable health) to 100 ('best' health state). The SNOT-22 allows a measure of sinonasal symptom severity, commonly used for CRS patients. This follows a Likert-scale response of 0 to 5 where 0 is 'No problem' and 5 is

'problem as bad as it could be' with total score ranging from 0 to 110. Higher total scores reflect worse symptom severity as well as daily functioning.

Costing methodology

Calculation of socioeconomic costs of CRS from a societal perspective was derived from a prevalence-based cost-of-illness method. This takes into account the direct (healthcare services costs and out-of-pocket expenditure) and indirect costs (productivity loss) within a given year. Monetary values are calculated in British pound sterling (GBP, £). All economic values were computed using 2014 figures which were the most appropriately available figures as the data were collected from 2013-2015. The final estimate of total socioeconomic cost of CRS were derived by extrapolating the three-monthly direct and indirect costs to the entire year.

Out-of-pocket expenditure (OOPE)

The total out-of-pocket expenditure (OOPE) costs were calculated as the sum of direct medical and non-medical OOPE over three months. We considered three months to be an appropriate recall period. Participants were asked to recall the amount of OOPE incurred from medication and equipment use over five domains: painkillers, cold and flu remedies, nasal sprays, other medication, and health devices or equipment. Additional medical out-of-pocket spending includes private and alternative healthcare costs. Non-medical OOPE included travel expenses for primary and secondary care appointments. CRS participants were asked to state method of travel (walk or cycle, hospital or community transport, car, or public transport/taxi) as well as total distance travelled, transport charges and car park cost. The total cost of private car travel is calculated by totaling the fuel cost and car park charges per clinic visit. The fuel cost per trip is estimated based on the official fuel cost per mile for 2014 of 13.57 pence using the Automobile Association (AA)[21] motoring cost. This cost per trip is then applied to the total number of encounters to primary and/or secondary healthcare appointments.

Health care service use

Information on healthcare service use assisted in the calculation of direct medical costs of CRS. Participants were asked to recall their service use both at primary care and secondary care levels. Primary care utilisation includes the number of consultations with GP and GP

practice nurses for both CRS and other reasons. Secondary care utilisation comprises of number of hospital visits; including outpatient and day-care appointments as well as inpatient hospital stay within the previous three months for both CRS and other reasons. The economic monetary estimate for direct medical cost was derived by multiplying healthcare utilisation with the respective unit costs. Unit costs were obtained from the year 2013/14 as outlined in national resources such as Personal Social Services Research Unit[22] and NHS Reference Costs[23] (See *Appendix 2*). For certain unit costs that were not available, similar national resources particularly from the previous year were used to complete the gaps in the data.

Productivity loss

Indirect costs were obtained by measuring productivity loss due to absenteeism and household productivity loss. Productivity loss related to presenteeism was not considered in this study due to the challenges in measuring reduced productivity whilst at work via a patient-reported questionnaire. A reduction in productivity is much less tangible than absence.

Absenteeism was measured using the question "In the last 3 months, around how many days have you been off work?" with responses distinguishing CRS to non-CRS reasons. The monetary cost of productivity loss due to absenteeism was derived using the human capital approach method[24] where production potential is based on average national earnings data. It is determined by multiplying the mean missed workdays per person by the average daily wage, based on the Annual Survey of Hours and Earnings; available on Office for National Statistics (See *Appendix 2*). In order to extrapolate annual cost burden, it was assumed that the average productivity level within the last three months was consistent over the course of the year.

Household productivity loss was calculated by asking patients who were not in employment (such as housewives and the retired group) the number of days they were unable to perform normal activities due to CRS in the last three months. These figures help to estimate the opportunity costs which is the potential income that could be earned by unpaid workers if they were to take up paid employment. Household productivity loss is reported separately from paid missed workdays due to the different costing valuation. This was calculated by assuming it was equal to the hourly wage of a housekeeper. Using the Annual Survey of Hours and Earnings, 2014, the daily earning for a housekeeper was calculated as £47.86.

Statistical Methods

Data collected were tabulated and analysed using SPSS Statistics for Macintosh version 23 (SPSS, Chicago, IL). Descriptive statistics were used to summarise the demographic, socioeconomic and quality of life variables. Due to the skewed cost data and non-normal distribution of total OOPE, the results were reported additionally using medians and interquartile range. Despite the non-normal distribution of cost data, standard non-parametric methods and analyses of costs or use of log transformations are generally inappropriate because they are not focused on arithmetic means. Therefore, parametric methods of comparing arithmetic means such as the t-test was used as it tends to be fairly robust to non-normality[25]. All comparisons were reported at the p=0.05 level of significance. ANOVA test were used to compare variables with more than 2 groups. Univariate analyses were used to test the possible associations between the key independent variables and total OOPE. These variables include demographics, socioeconomic as well as health-related quality of life score. A multivariate regression analysis was then performed to model the mean OOPE as a linear function of the independent variables. All potential variables with a p-value lower than 0.10 were selected for multiple regression analysis. The results of the multiple regression are presented in β values with associated p-values, and R^2. Variables that were significant in the multiple model at $p<0.05$ were considered predictive of total OOPE.

Results

Study Participants

From a total of 437 dispatched questionnaires, 212 questionnaires were returned (49% response rate); this was reduced to a final cohort of 206 after checking for duplicates and significant missing information. The cohort of 206 participants had an age range of 18 to 80 (see flowchart (figure 1) for details).

Descriptive and Outcome Data

The 206 participants comprised of 139 CRS participants and 67 control participants; 52.5% males and 47.5% females in the CRS group and 67.3% female and 32.7% male in the control group. CRS diagnosis were sub-categorised into 33.8% with CRSsNP, 58.3% with CRSwNP and

7.9% with AFRS. Demographic and socioeconomic participant characteristics are summarized in Table 2. The mean age for the CRS subjects was 58 years old ranging from 26 to 80 years old. The mean age in the control group was 41 years old ranging from 18-68 years old. The majority of participants were of white-British background and born in the UK (90-93%) reflecting the demographic of East Anglia. In terms of employment, 59% of CRS subjects and 71.7% of control subjects were employed either full time, part-time, or self-employed and 31% of participants had annual household income between £20, 000 - 40, 000. The majority (91.5%) of participants relied on public healthcare alone whilst 8.5% had additional private healthcare coverage. Just over half (51.8%) of CRS patients and 28.4% of control group were exempted from prescription charges.

Out-of-Pocket Expenditure (OOPE)

The total OOPE including direct medical and non-medical costs incurred from CRS management over a 3-month period are outlined in Table 3. The mean over-the-counter medication and health devices incurred by the CRS patient totalled to £30.54 (median £17.00, IQR £33.40) over the course of 3 months, which is significantly higher when compared to £5.74 (median £1.00, IQR £5.50) in adults without CRS ($p<0.001$). In summary, it was found that CRS subjects spend 5.3-fold greater than controls on over-the-counter medication. The mean total overall OOPE incurred over a 3-month period was significantly higher in CRS group at GBP £76.21 (median £44.23, IQR £71.18) in comparison to £12.68 (median £2.40, IQR £7.89) in adults without CRS ($p<0.001$). The total average OOPE per CRS patient is therefore estimated to be £304.84 per annum. Table 3 shows further breakdown of OOPE comparing CRSsNP group and CRSwNP. The t-test did not display any significant differences in direct medical OOPE, direct non-medical OOPE and total OOPE within these two main CRS phenotypes.

Healthcare resource utilisation

Table 4 summarises the use and costs of healthcare services; primary care and secondary care within a three-month duration. CRS subjects had significantly higher total number of primary care visits than the control group (4.14 vs. 1.16, $p<0.001$). This amounted to an average primary care visit cost per patient of £130.13 (median £92.00, IQR £115.00) in the CRS group compared to the control group at £40.84. This difference may be largely accounted by the additional visits incurred by CRS-related problems. On the utilisation of secondary care

services, CRS subjects recorded a higher outpatient interaction (2.61 vs 0.40, p<0.001) with an average total cost of £613.58 (median £166.00, IQR £512.00), as compared to £97.40 in the control group. Therefore, the mean number of secondary care visits and costs were approximately 6.3-fold greater for CRS patients when compared to the control group. This is largely due to the significantly higher outpatient visits and day-care visits by CRS participants for both CRS-related and non-CRS related reasons. The overall cost of both primary and secondary cost over 3 months amounted to £743.72 (median £286.00, IQR £673.00) for adult with CRS which were significantly higher than adults without CRS at £138.85 (median £41.70, IQR £59.70) p<0.001.

Productivity loss

The average number of workdays missed by employed participants due to CRS and non-CRS symptoms or treatments and its associated costs are outlined in Table 5. The mean workdays missed due to CRS reasons over a three-month period was 1.96 days (7.84 days per year). The mean total workdays missed accounting for CRS and non-CRS reasons over three months and its cost were found to be significantly higher for the CRS subject when compared to controls (4.68 vs 0.73, £566.07 vs. £88.14, p=0.007). On extrapolation, the average total workdays missed was estimated to be 18.7 days per patient per year. Within the CRS subtypes, there were no significant differences displayed in absenteeism between CRSsNP and CRSwNP. In terms of household productivity costs, adults with CRS who are not in employment spend a mean of 0.95 days (£45.47) over 3 months where they were unable to perform normal function. There were no significant differences displayed in total household productivity loss in adults with CRS and without CRS (p=0.825). A breakdown of absenteeism in number of days in CRS participants is presented in Table 8.

Societal cost and burden of CRS

The overall average three-monthly costs, which accounted for OOPE, primary and secondary care costs and productivity loss, are outlined in Table 9. When calculating the total socioeconomic cost of CRS, all aspects of direct and indirect medical care needs to be included. To calculate the annual healthcare cost per individual, the three-month costs were extrapolated by multiplying by four with an assumption that it was consistent over the course of the year. The estimated average total cost per individual patient is outlined in Table 10 and

further illustrated in Figure 2. Adults with CRS incur a total healthcare cost of £4844.88 per annum with an incremental difference of £3782.44 when compared to adults without CRS. Healthcare service costs are the primary driver of total CRS expenditures (Figure 3). This may be due to multiple outpatient visits due to difficulty symptom control. Based on a national prevalence of CRS of 11%, and a population of approximately 40 million in 2014, the total overall healthcare cost of a CRS patient including CRS and non-CRS related reasons, has been calculated to be approximately £21 billion in 2014. The estimated incremental increase of healthcare expenditure due to CRS is £16.8 billion per year in the UK based on 2014 estimates. (See *Appendix 2*).

Health Related-Quality of Life (HRQoL)

HRQoL of CRS patients were found to be below public average indicating a lower quality of life in CRS patients. Significant differences were displayed in mean scores between adults with CRS and control for SNOT-22, EQ-5D Index and VAS Health score. The average score for total SNOT-22 was 35.04 in the CRS group versus 5.64 in the control group ($p<0.001$). The mean EQ-5D index score for CRS patients were 0.77 which was significantly lower than the control group 0.936 (<0.001). The EQ-5D visual analogue health score was 72.81 in the CRS group and 89.85 in the control group. A further detailed breakdown of quality of life measures between the CRS subtypes is also reported in Table 10. Interestingly, CRSwNP reported better QoL than those with CRSsNP with statistically significant differences displayed in SNOT-22, $p=0.040$ and EQ-5D Index, $p=0.017$.

Associations of demographic and socioeconomic variables

The result of the initial univariate analysis assessed associations between total OOPE with demographic, socioeconomic and health related quality of life variables (Table 7). Higher total OOPE were associated with higher number of household occupancy, employment status, and higher annual income ($p<0.05$). Stepwise multivariate linear regression showed that number of household occupancy ($\beta=0.252$) and income ($\beta=0.221$) independently predicted higher total OOPE over the last three-month period. Even though statistically significant at p-value <0.05 level, the strength of the relationship is considered weak. The final regression model only accounted for 9.6 percent of the total variance in the total OOPE over three months. Other socioeconomic, demographic and HRQoL variables were not found to be predictive

factors of OOPE. A separate analysis on over-the-counter (OTC) medication costs was performed to assess associations with HRQoL variables. There was a significant correlation between OTC medication costs with higher symptom severity via the total SNOT-22 score (0.278, p=0.001). Over-the-counter medication costs were inversely related to QoL, with the correlation between the Health score and OTC medication costs being -2.57 (p=0.002) and EQ5D Index score of -0.215 (p=0.011).

Discussion

Key Results

When compared to studies of other chronic diseases socioeconomic data related to CRS is sparse and until now has lacked a comprehensive study in the UK. This study represents the first UK attempt to quantify the cost (OOPE) associated with CRS treatment particularly from an individual patient perspective. The total OOPE incurred per CRS patient is estimated to be £304.84 annually, in a publicly funded healthcare system. This study has demonstrated that CRS subjects incur a personal spend of 5.3-fold greater on OTC medication than the general population. This significant personal monetary burden can be contributed to by a number of factors that include: the chronic nature of CRS, frequent exacerbations of symptoms necessitating visits to primary and secondary healthcare services and incomplete symptom control leading to higher use of additional therapies and over-the-counter medication[26]. With respect to direct costs and health care utilization, adults with CRS attended an average of approximately 3 additional primary care visits and approximately 2 additional secondary care visits, over a three-month period when compared to controls.

Indirect costs take into account absenteeism (missed workdays), presenteeism (decreased productivity), as well as household productivity loss. In this study however, presenteeism was not evaluated due to the difficulty of estimating decreased productivity via a questionnaire-based study. It was found that the mean absenteeism rate over three months for CRS patients and controls were 4.68 and 0.73 respectively. On extrapolation, the estimated average of missed workdays was 18.7 per CRS patient per year.

Limitations

One of the limitations of this study is that the control group consisted of a higher proportion of female and younger participants when compared to CRS group, although this may be

attributed to the missing information on age and gender for 18 control participants. Moreover, there is a selection bias given that the CRS participants were recruited in secondary care only, where patients typically reflect the more severe cases and therefore, contributing to a group where direct and indirect costs may be much higher. Thus, results from this study may not be wholly generalizable to the wider UK population with CRS. An important component that was not included in the analysis is medication prescription costs that originated from primary or secondary care. Given the available data, a future analysis can be undertaken to calculate costs based on British National Formulary and NHS prescription fees. It should also be noted that the current data represent a combination of patient reported expenditures as well as derived costs from unit cost estimates applied to utilization measures. Additionally, the OOPE data displayed skewed distribution; due to a small number of patients who utilize large amounts of resources and by a high number of patients with zero or very small cost values. The most appropriate statistical approach for cost analysis is debated in existing literature, where some have argued that the median could be more representative than the mean as a measure of central tendency whilst others argue that the arithmetic mean should be used in healthcare cost analysis as it directly informs decision makers[27]. Therefore, it is worth noting that mean costs reported in this study may not be the typical costs for any individual participant. The extrapolation of a three-month health care cost to an annualized health care cost can also over or underestimate the true cost of the disease.

The indirect cost from productivity loss is an underestimate, as presenteeism costs were not factored together. This is largely due to the difficulty on estimating reduced productivity assumptions via a self-reported questionnaire. Another aspect that was that was not included in analysis were indirect costs of missed workdays due to informal care from caregiver and childcare costs in relation to CRS healthcare appointments. Despite these items being included in the questionnaire, most participants did not record any information related to these and when present, there were no recorded costs associated. Consequently, it can be assumed that the figures estimated in this study for direct and indirect cost due to CRS is potentially an under-estimate of the true monetary burden of CRS.

Interpretation

The previous research concerning the socioeconomic burden of CRS is limited with most studies carried out by the same principal investigator, Bhattacharya. In contrast, Bhattacharyya reported an annual average of 4.8 days missed workdays per CRS patient[8]. A

Canadian study by Yip *et al*.[28] estimated an average of 20.6 workdays missed per year whilst Rudmik *et al*. reported an average of 24.6 days per year for patients with refractory CRS[29] . Our findings may therefore be an estimate reflecting both refractory CRS and those with less severe phenotypes of CRS. Direct costs of disease are often subject to extrinsic factors such as economic cycles, legislative changes and health care utilisation[30]. On the other hand, indirect costs are associated with disease-specific QOL impairments. Our study showed that the average SNOT-22, EQ-5D index score, and health score of adults with CRS were lower than that in the general population. Higher OTC medication costs were associated with lower levels of health-related QOL. Thus, patient-borne cost can be minimised through effective, patient-centred treatments.

When looking at the burden to the society, a key finding of this study suggest that CRS has a considerable economic impact on the UK and the NHS, with an estimated incremental cost of £3782.44 attributable to CRS per individual per year. This figure includes healthcare costs, OOPE and productivity loss due to absenteeism as well as household productivity costs. An incremental estimate of £16.8 billion of healthcare cost was therefore attributed to CRS in 2014. This compares to an estimated €961.1 per individual/year for allergic rhinitis in a Swedish study [31]. In contrast, for CRS, Bhattacharyya[32] evaluated the US-based MEPS database in 2007 and reported an incremental direct healthcare expenditures estimate of $8.6 billion per year. However, it is worth noting that this figure did not include costs related to productivity loss and it was based on a lower CRS prevalence of approximately 5% (11.1 ± 0.48 million adult patients in the US).

Our results illustrate the distribution of CRS costs and their impact on patient, national healthcare system as well as to the employer. A key strength to this study is the use of a bottom-up approach to costing. Another strength to this study is the recall duration of three months, compared to other studies that is conducted over a 12-month recall period. Recording of expenditure are self-reported and thus patients may be subject to recall bias if the recall period is longer. It has been reported in studies on productivity loss that the accuracy of recall of missed workdays reduces to 51% at 1 year[33]. Future studies may include a further follow-up questionnaire after three to six months to allow a more accurate estimation of healthcare costs. A current programme of research underway also plans to establish the cost effectiveness and cost utility of medical and surgical treatment for CRS over a 6-month trial duration[34].

Generalisability

It is worth to note that the sample population in our study comprised of a high proportion of white-British (93%) which is not entirely representative of people with CRS in the UK population, as according to the 2011 Census, White British ethnic group made up approximately 80.5% of the UK population[35]. Apart from that, a large proportion of the CRS group comprised of participants in retirement (36%) and thus may underestimate the total health care cost, given that residents aged 65 years and over, represented approximately 18% of the total UK population (2016)[36]. Despite the limitations of this cost-of-illness analysis, the findings from this study provides an insight to the financial impact of CRS that is vital in program planning and public policy design. This study is the first representative costing exercise on the socioeconomic burden of CRS in the UK to date, with particular attention to characterising the out-of-pocket expenditure borne by the individual patient. Suggested areas for future studies would be to investigate and compare the economic cost of CRS with other similar chronic disease.

Conclusion

Overall, patients with CRS demonstrate a higher out-of-pocket expenditure, primary care and secondary care utilisation, and time lost from work compared to those without CRS. The study estimated an annual average OOPE of £304.84 secondary to CRS over the 3 month study period (in 2014), with a 5.3-fold greater spending on over-the-counter medication when compared to the general population. CRS is associated with an average 18.7 missed workdays per year and demonstrated an estimated incremental healthcare cost of £16.8 billion in 2014. Given that CRS is a chronic condition, and has significant prevalence and socioeconomic impact, it deserves attention from health authorities. Findings from this study will add important insights to the existing limited data in the UK and will directly inform NHS practice and aid in program planning and public policy design.

Declarations

Ethical approval and consent to participate

See above in methods.

Consent for publication

Not applicable.

Availability of data and material

The dataset will be made available via https://www.synapse.org/

Funding

The study was funded by the Anthony Long Trust (postage costs) and the Bernice Bibby Trust (research nurse time).

Competing interests

None.

Author contributions

According to the ICMJE authorship criteria:

1) substantial contributions to conception and design of, or acquisition of data or analysis and interpretation of data
2) drafting the article or revising it critically for important intellectual content
3) final approval of the version to be published

Carl Philpott 1, 2, 3
Allan Clark 1, 2, 3
Wahidah Wahid 1, 2, 3
Rupert Smith 1, 2, 3
Mahmoud Salam 1, 3

Acknowledgements

Sally Erskine for data collection
Ed Wilson for study design
Jane Woods, Research Nurse at the James Paget University Hospital for her dedication to the study.

References

1. Hastan D, Fokkens WJ, Bachert C, Newson RB, Bislimovska J, Bockelbrink A, et al. Chronic rhinosinusitis in Europe--an underestimated disease. A GA(2)LEN study. Allergy. 2011;66(9):1216-23.
2. Hospital Episode statistics, Department of Health. 2013.
3. Philpott C, Erskine S, Smith R, et al. Current use of baseline medical treatment in chronic rhinosinusitis: Data from the National Chronic Rhinosinusitis Epidemiology Study (CRES). Clin Otolaryngol. 2018; 43: 509-24
4. Vennik J, Eyles C, Thomas M, et al. Management strategies for chronic rhinosinusitis: a qualitative study of GP and ENT specialist views of current practice in the UK. BMJ open. 2018; 8: e022643
5. Erskine SE, Verkerk MM, Notley C, Williamson IG and Philpott CM. Chronic rhinosinusitis: patient experiences of primary and secondary care - a qualitative study. Clin Otolaryngol. 2016; 41: 8-14.
6. Philpott C, Hopkins C, Erskine S, et al. The burden of revision sinonasal surgery in the UK-data from the Chronic Rhinosinusitis Epidemiology Study (CRES): a cross-sectional study. BMJ open. 2015; 5: e006680
7. Goetzel RZ, Hawkins K, Ozminkowski RJ, Wang S. The health and productivity cost burden of the "top 10" physical and mental health conditions affecting six large U.S. employers in 1999. J Occup Environ Med. 2003;45(1):5-14.
8. Bhattacharyya N. The economic burden and symptom manifestations of chronic rhinosinusitis. Am J Rhinol. 2003;17(1):27-32.
9. Gliklich RE, Metson R. Economic implications of chronic sinusitis. Otolaryngol Head Neck Surg. 1998;118(3 Pt 1):344-9.
10. Bhattacharyya N. Contemporary assessment of the disease burden of sinusitis. Am J Rhinol Allergy. 2009;23(4):392-5
11. Ray NF, Baraniuk JN, Thamer M, Rinehart CS, Gergen PJ, Kaliner M, et al. Healthcare expenditures for sinusitis in 1996: contributions of asthma, rhinitis, and other airway disorders. J Allergy Clin Immunol. 1999;103(3 Pt 1):408-14.
12. Anand VK. Epidemiology and economic impact of rhinosinusitis. Ann Otol Rhinol Laryngol Suppl. 2004;193:3-5.
13. Gliklich RE, Metson R. Economic implications of chronic sinusitis. Otolaryngol Head Neck Surg. 1998;118(3 Pt 1):344-9.
14. Fokkens WJ, Lund VJ, Mullol J, Bachert C, Alobid I, Baroody F, et al. European Position Paper on Rhinosinusitis and Nasal Polyps 2012. Rhinol Suppl. 2012;23:3 p preceding table of contents, 1-298.
15. Bent JP, 3rd, Kuhn FA. Diagnosis of allergic fungal sinusitis. Otolaryngol Head Neck Surg. 1994;111(5):580-8.
16. Fox M, Voordouw J, Mugford M, Cornelisse J, Antonides G, Frewer L. Social and economic costs of food allergies in Europe: development of a questionnaire to measure costs and health utility. Health Serv Res. 2009;44(5 Pt 1):1662-78.
17. Greiner W, Weijnen T, Nieuwenhuizen M, Oppe S, Badia X, Busschbach J, et al. A single European currency for EQ-5D health states. Results from a six-country study. Eur J Health Econ. 2003;4(3):222-31.
18. Norfolk and Suffolk Primary and Community Care Research Office . Available at: https://nspccro.nihr.ac.uk/working-with-us/public-patient-and-carer-voice-in-research
19. EuroQol-Group. EQ-5D-5L. 2009. Available at: https://euroqol.org/eq-5d-instruments/eq-5d-5l-about/
20. Hopkins C, Gillett S, Slack R, Lund VJ and Browne JP. Psychometric validity of the 22-item Sinonasal Outcome Test. *Clin Otolaryngol*. 2009; 34: 447-54

21. Automobile Association (AA) motoring costs 2014 Available at: http://www.theaa.com/motoring_advice/motoring_costs.html
22. Curtis L. Unit Costs of Health and Social Care 2014. Canterbury. Personal and Social Services Research Unit University of Kent 2014.
23. Payment by Results in the NHS: tariff for 2013 to 2014. Available at: https://www.gov.uk/government/publications/payment-by-results-pbr-operational-guidance-and-tariffs (last accessed 08/04/2019).
24. Hodgson TA, Meiners MR. Cost-of-illness methodology: a guide to current practices and procedures. Milbank Mem Fund Q Health Soc. 1982;60(3):429-62.
25. Barber JA, Thompson SG. Analysis and interpretation of cost data in randomised controlled trials: review of published studies. BMJ. 1998;317(7167):1195-200
26. Bhattacharyya N, Orlandi RR, Grebner J, Martinson M. Cost burden of chronic rhinosinusitis: a claims-based study. Otolaryngol Head Neck Surg. 2011;144(3):440-5.
27. Mogyorosy Z, Smith P. The main methodological issues in costing health care services: A literature review. *Working Papers* 007cherp, Centre for Health Economics, University of York
28. Yip J, Vescan AD, Witterick IJ, Monteiro E. The personal financial burden of chronic rhinosinusitis: A Canadian perspective. Am J Rhinol Allergy. 2017;31(4):216-21.
29. Rudmik L, Smith TL, Schlosser RJ, Hwang PH, Mace JC, Soler ZM. Productivity costs in patients with refractory chronic rhinosinusitis. Laryngoscope. 2014;124(9):2007-12.
30. Catlin, AC., Cowan, CA. Centers for Medicare and Medicaid Services. History of Health Spending in the United States, 1960-2013. 2015. Available at: https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/Downloads/HistoricalNHEPaper.pdf (last accessed 28/04/2019)
31. Cardell LO, Olsson P, Andersson M, Welin KO, Svensson J, Tennvall GR, et al. TOTALL: high cost of allergic rhinitis-a national Swedish population-based questionnaire study. NPJ Prim Care Respir Med. 2016;26:15082.
32. Bhattacharyya N. Incremental health care utilization and expenditures for chronic rhinosinusitis in the United States. Ann Otol Rhinol Laryngol. 2011;120(7):423-7.
33. Zhang W, Bansback N, Anis AH. Measuring and valuing productivity loss due to poor health: A critical review. Soc Sci Med. 2011;72(2):185-92.
34. Philpott C, le Conte S, Beard D, et al. Clarithromycin and endoscopic sinus surgery for adults with chronic rhinosinusitis with and without nasal polyps: study protocol for the MACRO randomised controlled trial. *Trials*. 2019; 20: 246.
35. GOV.UK. Ethnicity facts and figures: UK population by ethnicity. Available at: https://www.ethnicity-facts-figures.service.gov.uk/uk-population-by-ethnicity/national-and-regional-populations/population-of-england-and-wales/latest
36. ONS. Living longer: how our population is changing and why it matters. Available at: https://www.ons.gov.uk/peoplepopulationandcommunity/birthsdeathsandmarriages/ageing/articles/livinglongerhowourpopulationischangingandwhyitmatters/2018-08-13
37. Curtis L. Unit Costs of Health and Social Care 2013. Canterbury. Personal and Social Services Research Unit University of Kent 2013
38. ONS (2014a). Labour Market Statistics, June 2014. Available at: https://webarchive.nationalarchives.gov.uk/20160105211820/http://www.ons.gov.uk/ons/rel/lms/labour-market-statistics/june-2014/statistical-bulletin.html (last accessed 08/04/2019).
39. ONS (2014b). Annual Survey of Hours and Earnings, 2014 Provisional Results. [Table 1.5a Hourly pay - Gross (£) - For all employee jobs: United Kingdom, 2014]. Available at: https://webarchive.nationalarchives.gov.uk/20141205191703/http://www.ons.gov.uk/ons/rel/ashe/annual-survey-of-hours-and-earnings/2014-provisional-results/index.html (last accessed 08/04/2019)

40. OECD (2014). Average annual hours actually worked per worker. Available at: https://stats.oecd.org/Index.aspx?DataSetCode= ANHRS (last accessed 08/04/2019).
41. ONS (2011). Summary: UK Population Projected to Reach 70 Milllion by Mid-2027. Available at: http://www.ons.gov.uk/ons/rel/npp/ national-population-projections/2010-based-projections/sum-2010-based-national-population-projections.html (last accessed 08/04/2019).
42. ONS (2014b). Annual Survey of Hours and Earnings, 2014 Provisional Results. [Figure 19: Median full-time gross weekly earnings by major occupation group, United Kingdom, 2014]. Available at: https://webarchive.nationalarchives.gov.uk/20141205191703/http://www.ons.gov.uk/ons/rel/ashe/annual-survey-of-hours-and-earnings/2014-provisional-results/index.html (last accessed 08/04/2019).

Tables

Table 1: Comparison of demographic characteristics in participants with CRS and without CRS

Participant Characteristics		CRS		Without CRS	
		No.	(value)	No.	(value)
Age, mean (range)		58 (26-80)		41 (18-68)	
Age category (%) *	1-20 years old	12	8.6	2	5.4
	21-40 years old	0	0.0	19	51.4
	41-60 years old	67	48.2	11	29.7
	61-80 years old	60	43.2	5	13.5
Gender (%) *	Male	66	52.5	16	32.7
	Female	73	47.5	33	67.3
CRS subgroup (%)	CRSsNP	47	33.8	-	
	CRSwNP	81	58.3	-	
	AFRS	11	7.9	-	
Country of birth (%)	UK	127	91.4	61	91.0
	Other	12	8.6	6	9.0
Ethnicity (%)	White British	127	92.7	60	90.9
	White Irish	2	5.0	0	0.0
	White Other	7	5.1	4	6.1
	Black/British-Caribbean	1	0.7	0	0.0
	Asian/Asian British-Other	0	0.0	1	1.5
	Mixed Other	0	0.0	1	1.5
Age on leaving education (%)	< 16 y	29	20.9	7	10.4
	16 y	41	29.5	16	23.9
	17-18 y	24	17.3	17	25.4
	>19 y	43	30.9	20	29.9
	Still studying	2	1.4	7	10.4
Qualification (%)	None	17	12.2	5	7.5
	CSE	6	4.3	2	3
	GCSE / O-Levels	25	18.0	8	11.9
	NVQ	9	6.5	4	6.0
	A-levels	8	5.8	12	17.9
	School certificate	2	1.4	0	0.0
	HND / Btec	7	5.0	8	11.9
	Degree	40	28.8	23	34.3
	Other	25	18.0	5	7.5
Living arrangements (%)	Alone	17	12.2	5	7.5
	Spouse	62	44.6	22	32.8
	Spouse & Parent	2	1.4	2	3.0
	Spouse & Children	43	30.9	19	28.4
	Spouse & Other	3	2.2	1	1.5
	Parent	1	0.7	7	10.4
	Parent & Other	0	0.0	1	1.5
	Children	7	5.0	1	1.5

	Friends	2	1.4	8	11.9
	Other	1	0.7	1	1.5
Number of household (%)	1	16	11.5	5	7.5
	2	65	46.8	26	38.8
	3	32	23.0	19	28.4
	4	15	10.8	12	17.9
	>5	11	7.9	5	7.5
Marital status (%)	Single	11	7.9	17	25.4
	Married / Partner	110	79.1	44	65.7
	Separated	15	10.8	6	9.0
	Widowed	3	2.2	0	0.0
Employment (%)	Full-time	38	27.3	31	46.3
	Part-time	25	18.0	15	22.4
	Self-employed	19	13.7	2	3.0
	Student	2	1.4	8	11.9
	Other	1	0.7	0	0.0
	Housewife/husband	4	2.9	2	3.0
	Retired	50	36.0	9	13.4
Annual income (%)	< £ 10, 000	13	9.4	13	19.4
	£ 10, 000 - 20,000	26	18.7	10	14.9
	£ 20, 000 - 40, 000	44	31.7	21	31.3
	£ 40, 000 - 60,000	16	11.5	6	9.0
	> £ 60, 000	16	11.5	7	10.4
	Prefer not to say	24	17.3	10	14.9
Benefits (%)	None	66	47.5	45	67.2
	State pension	41	29.5	10	14.9
	Child benefit	16	11.5	8	11.9
	Other	9	6.5	0	0.0
	Mixed	7	5.0	4	6.0
Prescription drug coverage,	Paid	67	48.2	48	71.6
no (%)	Exempted	72	51.8	19	28.4
Method of prescription	Individually	39	60.0	44	95.7
payment (%)	3-monthly	6	9.2	0	0.0
	Yearly	20	30.8	2	4.3
Healthcare (%)	Public only	128	92	61	91.0
	Additional private cover	11	8.0	6	9.0
Work environment (%)	Outdoor	7	8.0	6	12.2
	Indoor	80	92.0	43	87.8
Work Type (%)	Manual	27	32.9	14	29.2
	Non-manual	55	67.1	34	70.8
Mean Time suffered (years)			16.0		0.0
Time suffered	1-15 years	85	61.2	-	
	16-30 years	40	28.8	-	
	31-45 years	11	7.9	-	
	>45 years	3	2.1	-	

Mean SNOT-22 score, no. (mean)		35.04		5.64
EQ-5D Index (mean)		0.77		0.94
EQ-VAS Health score (mean)		72.81		89.85

*Missing data on age and gender on 18 control participants, and missing data on age only for 12 control participants

Table 2: Average 3-monthly OOPE per patient in adults with CRS and adults without CRS (2014, in GBR £)

Variable	CRS group (n=139)			Without CRS (n=67)			
	Mean	**Median**	**IQR**	**Mean**	**Median**	**IQR**	***p***
Direct medical OOPE (£):							
Medication & Health equipment:							
Pain-relief	4.83	1.00	(5.00)	2.80	1.00	(2.00)	0.149
Cold and flu remedies	3.63	0.00	(2.00)	0.73	0.00	(0.00)	0.005
Nasal sprays	8.60	0.00	(12.0)	0.14	0.00	(0.00)	<0.001
Other medication	6.11	0.00	(4.22)	1.75	0.00	(0.00)	0.003
CRS related - Health devices	6.64	0.00	(9.00)	0.00	0.00	(0.00)	<0.001
Non-CRS related - Health devices	0.72	0.00	(0.00)	0.31	0.00	(0.00)	0.473
Total over-the-counter OOPE	30.54	17.00	(33.40)	5.74	1.00	(5.50)	<0.001
Private and Alternative healthcare:							
CRS - Alternative therapist	1.57	0.00	(0.00)	0.00	0.00	(0.00)	0.244
CRS - Private practitioner	0.00	0.00	(0.00)	0.00	0.00	(0.00)	1.00
Non-CRS - Alternative therapist	5.83	0.00	(0.00)	4.33	0.00	(0.00)	0.591
Non-CRS - Private practitioner	1.16	0.00	(0.00)	1.05	0.00	(0.00)	0.781
Total Direct medical OOPE	39.31	19.98	(40.37)	9.96	1.00	(3.50)	<0.001
Direct non-medical OOPE (£):							
Transport cost:							
CRS - Primary care visits	1.06	0.00	(1.50)	0.00	0.00	(0.00)	<0.001
CRS - Secondary care visits	22.47	5.80	(9.74)	0.00	0.00	(0.00)	<0.001
Non-CRS Primary care visits	1.55	0.00	(1.66)	1.04	0.00	(1.50)	0.741
Non-CRS - Secondary care visits	11.82	0.00	(3.63)	1.69	0.00	0.00	0.015
Total direct non-medical OOPE	36.90	10.45	(21.92)	2.73	0.00	(1.50)	<0.001
Total Overall OOPE	76.21	44.23	(71.18)	12.68	2.40	(7.89)	<0.001

Table 3: Average 3-monthly OOPE per patient comparing CRSsNP and CRSwNP group (2014, in Great British Pound £).

	CRSsNP (n=47)			**CRSwNP** (n=81)			**AFRS** (n=11)			
	Mean	Median	IQR	Mean	Median	IQR	Mean	Median	IQR	*p*
Direct medical	37.03	19.95	57.00	38.67	20.72	39.6	50.26	20.00	27.28	0.858
Direct non medical	27.05	11.61	18.00	44.99	11.10	29.73	20.18	8.10	23.09	0.283
Overall OOPE	64.08	44.50	66.09	83.10	45.29	76.74	70.44	30.60	26.18	0.313

Table 4: Healthcare utilisation and cost over 3 months in group with CRS and without CRS

	CRS (n=139)			Without CRS (n=67)			
Variable	Mean	Median	IQR	Mean	Median	IQR	*p*
CRS services							
Total Primary Care - CRS visits	1.91	1.00	2.00	0	0	0	<0.001
Total Primary care - CRS costs (£)	58.64	46.00	92.00	0	0	0	<0.001
Total Secondary Care-CRS visits	1.60	1	1	0	0	0	<0.001
Total Secondary Care-CRS costs (£)	308.55	83.00	83.00	0	0	0	<0.001
Non-CRS services							
Total Primary Care-Other visits	2.24	1	3	1.16	1	1	<0.001
Total Primary Care-Other costs (£)	71.49	46.00	92.00	40.84	13.70	46.00	0.016
Total Secondary Care-Other visits	1.01	0	1	0.40	0	0	0.042
Total Secondary Care-Other costs (£)	305.03	0	128	97.40	0	0	0.048
Total							
Total Primary Care Visits	4.14	2.00	4.00	1.16	1.00	2.00	<0.001
Total Primary Care Costs	130.13	92.00	115.00	40.84	13.70	46.00	<0.001
Total Secondary Care Visits	2.61	2.00	2.00	0.40	0.00	0	<0.001
Total Secondary Care Costs	613.58	166.00	512.00	97.40	0	0	<0.001
Total cost primary and secondary care	743.72	286.00	673.00	138.85	41.70	59.70	<0.001

Table 5: Workdays lost and its estimated absenteeism costs by employed adults with CRS and without CRS over 3-month period

Table 6: Workdays lost and its estimated absenteeism costs by employed patients in CRSsNP and CRSwNP group

Participants in employment	**CRS (n=82)**		**Without CRS (n=48)**		
	Mean (range)	Cost (£)	Mean (range)	Cost(£)	*p*
Missed work days due to CRS	1.96(0-35)	236.92	0	0	0.001
Missed work days due to non-CRS reasons	2.72(0-84)	328.79	0.73(0-8)	88.14	0.137
Total missed work days	4.68(0-84)	566.07	0.73(0-8)	88.14	0.007

Participants in employment	**CRSsNP (n=22)**	**CRSwNP (n=53)**	
	Mean (range)	Mean (range)	*p*
Missed work days due to CRS	1.77(0-14)	1.45(0-16)	0.711
Missed work days due to non-CRS reasons	0.45(0-3)	3.85(0-84)	0.098
Total missed work days	2.23(0-14)	5.30(0-84)	0.343

Table 7: Household productivity loss and its estimated costs by unemployed patients over 3-month period

	CRS	**Without CRS**

Participants not in employment	(n=57)		(n=19)		
	Mean (range)	Cost	Mean (range)	Cost	*p*
No. of days unable to perform normal function due to CRS	0.95(0-11)	£45.47	0	0	0.006
No. of days unable to perform normal function due to non-CRS reasons	2.00(0-90)	£95.72	3.68 (0-60)	£176.32	0.611
Total no. of days unable to perform normal function	2.95(0-90)	£141.06	3.68 (0-60)	£176.32	0.825

Table 8: Distribution of missed workdays period across the CRS subtypes over 3-month period

	0 days	1-7 days	8-14 days	15-30 days	>30 days	Total
CRSsNP	15	5	2	0	0	22
CRSwNP	39	11	2	1	0	53
AFRS	4	1	1	0	1	7
Total	57(69.5%)	17(20.7%)	5(6.1%)	1(1.2%)	1(1.2%)	82

Table 9: Average 3-monthly costs for CRS patients and control (2014, in Great British Pound £)

	CRS (n=139)				Without CRS (n=67)				
	Mean	±SD	Median	IQR	Mean	±SD	Median	IQR	*p*
OOPE:									
Direct medical	39.31	(53.93)	19.98	40.37	9.93	(25.77)	1.00	7.00	<0.001
Direct non-medical	36.90	(87.38)	10.45	21.92	6.53	(22.28)	0	2.90	<0.001
Subtotal	75.67	(101.76)	44.00	71.18	15.68	(32.42)	2.90	14.00	<0.001
Health Care Costs:									
Primary Care	130.15	(145.52)	92.00	115.00	40.84	(73.54)	13.70	46.00	<0.001
Secondary Care	613.58	(1052.71)	166.00	512.00	95.94	(597.69)	0	0	<0.001
Subtotal	743.73	(1083.54)	286.00	673.00	136.78	(652.03)	41.70	59.70	<0.001
Productivity loss:									
Absenteeism	566.07	(1554.75)	0	362.64	88.14	(202.18)	0	120.88	0.007
Household productivity loss	141.06	(580.44)	0	0	176.32	(661.83)	0	0	0.825
Subtotal	391.78	(1264.73)	0	241.76	113.15	(387.52)	0	0	0.019
TOTAL COSTS	1211.18	(1808.10)	496.50	928.78	265.61	(790.99)	48.36	156.90	<0.001

Table 10. Total annual estimate of healthcare expenditure comparing CRS group versus Control

Expenditure Items	Average total cost per patient			
	Adults with CRS		Adults without CRS	
	3-monthly	Annual Estimate	3-monthly	Annual Estimate
Healthcare services	743.73	2974.92	136.78	547.12
OOPE	75.67	304.84	15.68	62.72
Productivity loss	391.78	1567.12	113.15	452.60

Total	1211.18	**4844.88**	265.61	**1062.44**
Annual incremental difference:	**£3782.44**			

Table 11. Significant differences (p<0.001) displayed in mean scores between adults with CRS and without CRS for SNOT-22, EQ-5D Index and Health score. *p=0.040, **p=0.017 compared with CRSsNP

	CRS						Without CRS (n=67)		
	CRSsNP (n=47)		**CRSwNP** (n=81)		**AFRS** (n=11)				
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	*p*
Total SNOT-22	41.00	23.065	32.46*	21.801	27.91	20.137	5.64	9.556	<0.001
EQ-5D Index	0.706	0.224	0.797**	0.151	0.839	0.112	0.936	0.100	<0.001
Health Score	70.47	21.322	73.83	18.980	75.36	13.764	89.85	8.900	<0.001

Table 12. Univariate analysis and stepwise multiple linear regression model predicting total OOPE from the past 3 months

Variable	Significance	Standardized β Coefficient	R^2
Univariate analysis			
Demographic variables:			
Age	0.278		
Gender	0.092		
Marital Status	0.657		
Diagnosis	0.589		
Time suffered	0.993		
Socioeconomic variables:			
Household occupancy	**0.002**		
Age at leaving education	0.104		
Highest Academic Qualification	0.157		
Employment status	0.016		
Annual income	0.047		
Benefits Status	0.767		
Work environment	0.985		
Work type	0.080		
Prescription drug coverage	0.417		
Additional private healthcare	0.239		
HRQOL variables:			
SNOT-22	0.595		
EQ-5D Index	0.911		
EQ-VAS Health Score	0.293		
Final Stepwise multiple regression			0.097
Income	**0.040**	0.221	
Household occupancy	**0.020**	0.252	

Figure Legends:

Figure 1: Participant flow

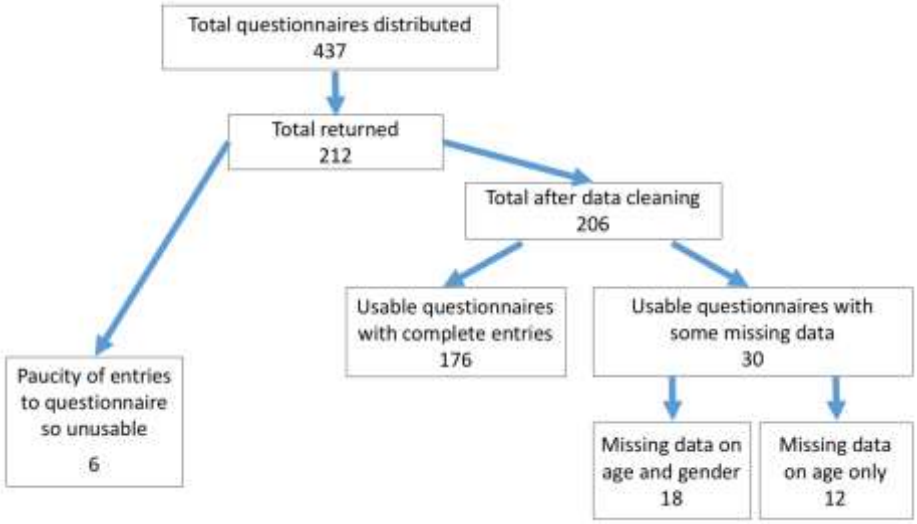


Figure 2: Estimated average break down of overall healthcare costs in adults with CRS and without CRS per annum (2014, £)

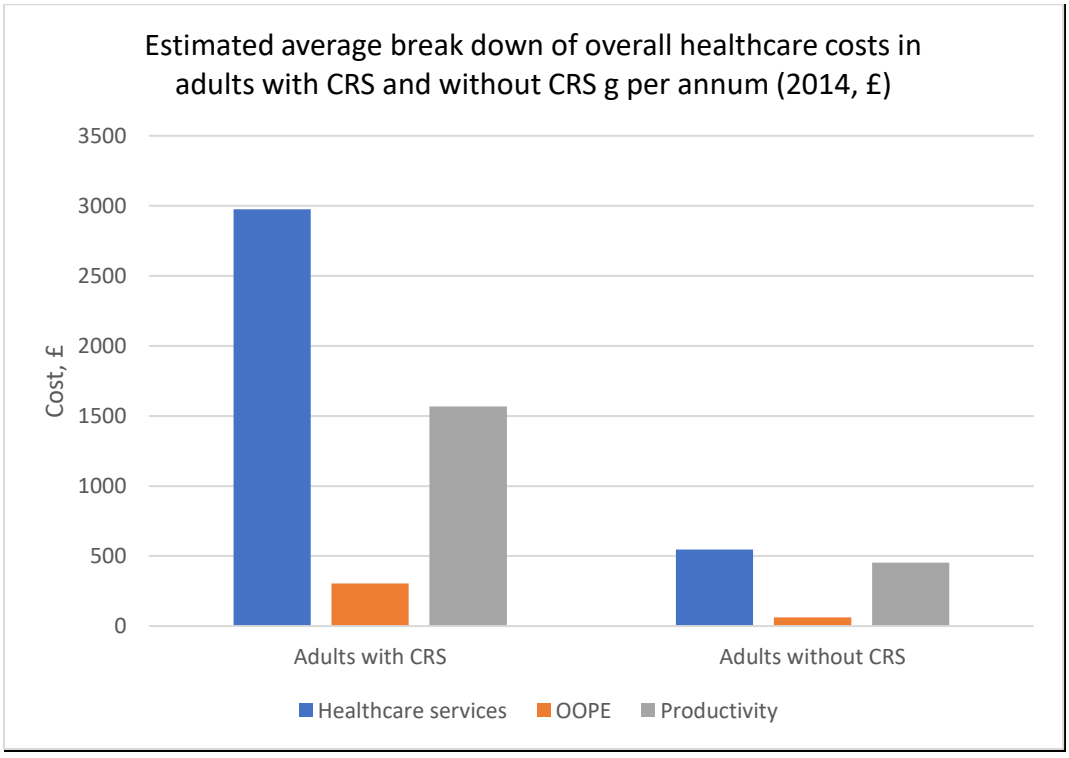
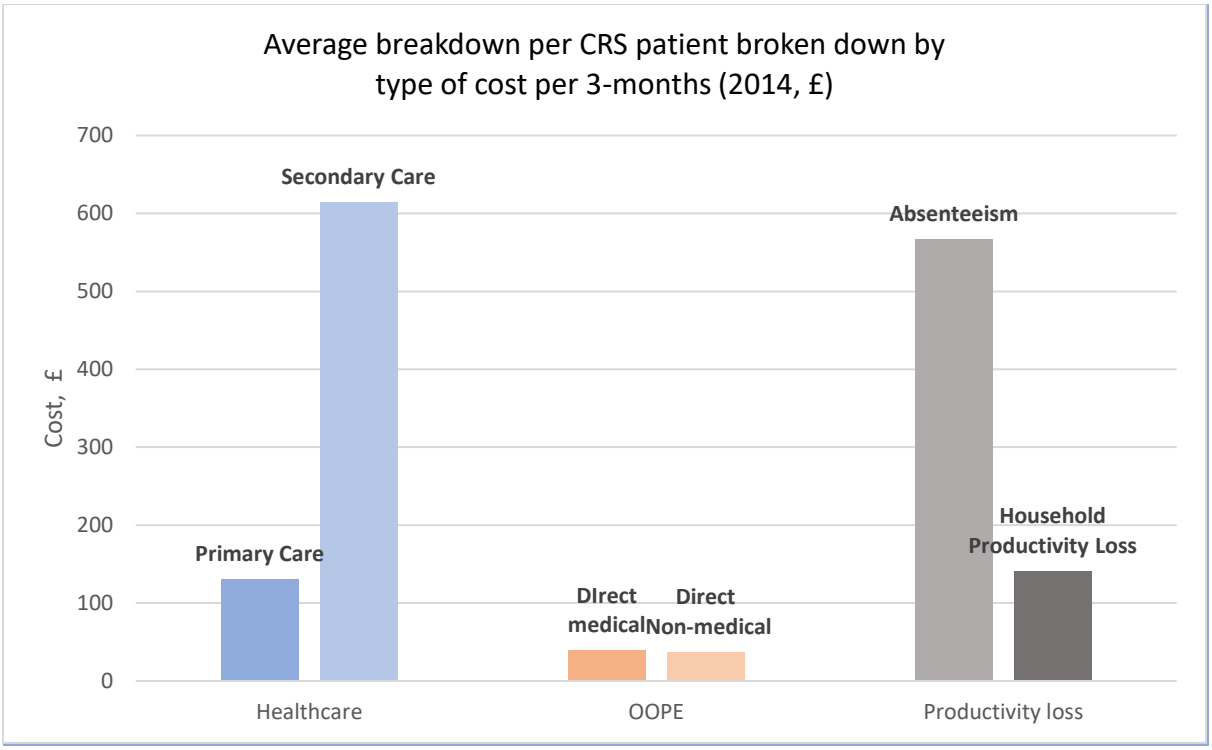


Figure 3: Average breakdown per CRS patient broken down by type of cost per 3 months (2014,£)



Appendices:

Appendix 1: Study questionnaire

UEA Office Use only: ☐☐☐☐ Local Ref: ☐☐☐☐

Please try to fill in ALL parts of the questionnaire, even if you do not have sinus problems and do not feel they are directly relevant to you.

University of East Anglia

The Socioeconomic Cost of Chronic Rhinosinusitis (SoCCoR) Study

Recruitment Questionnaires

FOR DOCTOR TO COMPLETE:

CRS WITHOUT POLYPS ☐

CRS WITH POLYPS ☐

CONFIRMED/SUSPECTED AFRS ☐

CONTROL ☐

CONFIRMATION OF DIAGNOSIS WITH:

CT SCAN ☐ ENDOSCOPY ☐

RECRUITMENT SITE

JPUH ☐ QEHB ☐

RSCH ☐ NUH ☐

GSTH ☐ FH ☐

Other ☐

Other, please specify: _____

Please return the questionnaire to the Norwich Medical School, UEA, Norwich - for the attention of Mr Carl Philpott

The Socioeconmic Cost of Chronic Rhinosinusitis (SoCCoR) Study

Assessment: **Background** Date: D D / M M / Y Y Y Y

This questionnaire collects some background information about you and your household, including your social and economic circumstances. These things have been shown to have important links to health. Please read the questions carefully and tick the relevant boxes or provide information when requested.

A) Background & education

1. What is your country of birth? UK ☐ Other ☐ Please specify

2. Using the attached sheet please enter the code of your ethnic background? N N

3. At what age did you leave full-time education? Less than 16 ☐ 16 ☐ 17-18 ☐ 19+ ☐
   Still in full-time education ☐

4. What is the highest level of qualification you have obtained?
   None ☐ CSEs ☐ GCSEs/O-levels ☐ NVQs ☐ A-levels ☐ School certificate ☐
   HND/BTec ☐ Degree ☐ Other ☐ Please specify

B) Living arrangements

5. What other people share your home?
   None, living alone ☐ Children ☐ Number of children N
   Spouse/partner ☐ Friends ☐ Number of friends N
   Parent(s) ☐ Others ☐ Please specify

6. What is the total number of people living in your home? N

7. How would you describe your marital status?
   Single (never married) ☐ Separated/Divorced ☐
   Married/civil partnership/living with partner ☐ Widowed ☐

C) Employment & economic circumstances

8. Which of the following categories best describe <u>your employment status</u>? *(Please tick all that apply)*
   Full-time paid employment ☐ Housewife/husband ☐
   Part time paid employment ☐ Unable to work due to illness/disability ☐
   Self-employed ☐ Unemployed ☐
   Student ☐ Retired ☐
   Other (e.g. voluntary work) ☐ Please specify

9. If you are in paid employment, what is your occupation or job title?

what type of environment do you work in? outdoors ☐ indoors ☐

is your work mainly? manual ☐ non-manual ☐

10. Which of the following amounts is closest to your gross (i.e. before tax) household income per year?

< £10,000 ☐ £20,001 - £40,000 ☐ Over £60,000 ☐

£10,001 - £20,000 ☐ £40,001 - £60,000 ☐ Prefer not to say ☐

11. Do you or your household receive any of the following welfare benefits? *(Please tick all that apply)*

None ☐ State pension ☐ Child Benefit ☐

Other ☐ Please specify

12. Do you pay for your prescriptions? Yes ☐ No ☐

If yes, how do you pay for your prescriptions? Individually ☐ 3-monthly ☐ Yearly ☐

D) Health issues

13. Approximately how long have you suffered with chronic rhinosinusitis? ☐☐ years.

14. Do you have private health insurance? Yes ☐ No ☐

If yes, how long have you had this for? ☐☐

...and what level of cover do you have?

The Socioeconmic Cost of Chronic Rhinosinusitis (SoCCoR) Study

Assessment: **Baseline** Date: D D / M M / Y Y Y Y

These questions help us to understand how your chronic rhinosinusitis (CRS) affects your use of health services and how much your chronic rhinosinusitis costs you and your family. Please read the questions carefully and tick the relevant boxes or provide information when requested. If you cannot remember things exactly please give your best estimate. Feel free to add any of your own notes. All responses are confidential and your data will be handled in the way described on the consent form you signed to take part in this study. In particular no information that could lead to you being identified from your responses will be released.

A) Hospital visits

1. In the last 3 months, how many times have you been in **hospital**?

	for your CRS?	for other reasons?	
For an outpatient appointment	N	N	
For a daycare appointment	N	N	
Admitted as an inpatient (no.of nights)	N	N	No. of Nights: N N

In relations to visits for CRS:

2. When you **travel** to the hospital how do you normally get there?
(for costs please use your best guess if you can't remember exact amounts)

Walk or cycle	☐	Return distance (miles):	N N N
Hospital or community transport	☐	Charge for this:	£ £ . p p
Car	☐	Parking cost:	£ £ . p p
Public transport or taxi	☐	Cost of return fare:	£ £ . p p

3. Around how much time would an ordinary **outpatients visit** to this hospital normally take out of your day, including travelling, waiting and consultation time? ☐☐ hour(s):

4. Do you have to take **time off** work to attend your hospital appointments? Yes ☐ No ☐

If yes, do you: Lose pay ☐ Get full pay ☐ Get sick pay ☐ I am not in employment ☐

5. Does somebody else usually **accompany** you to the hospital? Yes ☐ No ☐

If yes, do they: Lose pay ☐ Get full pay ☐ Not work ☐

6. Do you need to arrange **child care** or **care for someone else** when you go to the hospital? Yes ☐ No ☐

If yes, please provide details of any cost involved: _____

B) Community health and social services

7. In the last 3 months, how many times have you consulted your **GP**?

	for your CRS?	for other reasons?
At the Surgery	N	N
At home	N	N
Over the phone	N	N

8. In the last 3 months, how many times have you consulted a **nurse** from your local surgery?

	for your CRS?	for other reasons?
At the Surgery	N	N
At home	N	N
Over the phone	N	N

9. When you **travel** to your GP how do you normally get there?
(for costs please use your best guess if you can't remember exact amounts)

Walk or cycle	☐	Return distance (miles):	N N N
Hospital or community transport	☐	Charge for this:	£ £ . p p
Car	☐	Parking cost:	£ £ . p p
Public transport or taxi	☐	Cost of return fare:	£ £ . p p

10. Around how much **time** would a visit to the GP surgery normally take out of your day, including travelling, waiting and consultation time? N N hour(s):

11. Do you have to take **time off** work to attend appointments at the GP surgery? Yes ☐ No ☐

If yes, do you: Lose pay ☐ Get full pay ☐ Get sick pay ☐ I am not in employment ☐

12. Does somebody else usually **accompany** you to the GP surgery? Yes ☐ No ☐

If yes, do they: Lose pay ☐ Get full pay ☐ Not work ☐

13. Do you need to arrange **child care** or **care for someone else** when you go to the GP surgery? Yes ☐ No ☐

If yes, please provide details of any cost involved:

C) Private and Alternative Healthcare

14. In the last 3 months, how many times have you seen a complementary therapist or alternative medicine practitioner?
e.g. acupuncturist, homeopath, chiropractor, osteopath, reflexologist, naturopath?

Type of practitioner seen (and no of times):	No. of times?:	Amount paid for your CRS?:	Amount paid for other reasons?:
	N N	£ £ . p p	£ £ . p p
	N N	£ £ . p p	£ £ . p p

15. In the last 3 months, how many times have you paid for any private health care? *e.g doctor, physiotherapist*

Type of practitioner seen (and no of times):	No. of times?:	Amount paid for your CRS?:	Amount paid for other reasons?:
	N N	£ £ . p p	£ £ . p p
	N N	£ £ . p p	£ £ . p p

D) Medications and equipment

16. In the last 3 months, have you paid for any **non-prescription ("over the counter") medicines under the following categories (for any reason, not just your CRS - use approximate costs):**

Pain killers (e.g. paracetamol, aspirin)

Name of product | Total spent on product over last three months

Cold and 'flu remedies (e.g. 'flu powders, decongestant tablets or inhaltion remedies, cough sweets/syrups)

Name of product | Total spent on product over last three months

Nasal sprays (e.g. beclomethasone, sinus rinses)

Name of product | Total spent on product over last three months

Other (e.g. vitamins & minerals)

Name of product | Total spent on product over last three months

17. In the last 3 months have you been issued with or bought any **health aids, devices or equipment** you have not already told us about in previous questions?
e.g. sinus bottles, tissues, etc.

for your CRS

Item	own cost	Or from: GP	Social services	Hospital
	£ £ . p p	☐	☐	☐
	£ £ . p p	☐	☐	☐
	£ £ . p p	☐	☐	☐

for other reasons?

Item	own cost	Or from: GP	Social services	Hospital
	£ £ . p p	☐	☐	☐
	£ £ . p p	☐	☐	☐

18. How many prescriptions have you paid for:

.....for CRS N N for other diseases N N (exempt from charges) N N

E) Phone calls

19. In the last 3 months, around how many **phone calls** have you made to any health or social services (excluding any you have already told us about in previous questions (7 & 8)? N N

F) Days off

20. In the last 3 months, around how many days have you been **off work** and/or **unable to perform your normal activities:**

because of your CRS? (days) N N for other reasons? (days) N N

21. When you are unwell, does someone else usually give up time to **look after you**? Yes ☐ No ☐

If yes, do they: Lose pay ☐ Get full pay ☐ Not work ☐

Under each heading, please tick the ONE box that best describes your health TODAY

Mobility

I have no problems in walking about ☐
I have slight problems in walking about ☐
I have moderate problems in walking about ☐
I have severe problems in walking about ☐
I am unable to walk about ☐

Self-Care

I have no problems washing or dressing myself ☐
I have slight problems washing or dressing myself ☐
I have moderate problems washing or dressing myself ☐
I have severe problems washing or dressing myself ☐
I am unable to wash or dress myself ☐

USUAL ACTIVITIES *(e.g. work, study, housework, family or leisure activities)*

I have no problems doing my usual activities ☐
I have slight problems doing my usual activities ☐
I have moderate problems doing my usual activities ☐
I have severe problems doing my usual activities ☐
I am unable to do my usual activities ☐

Pain/Discomfort

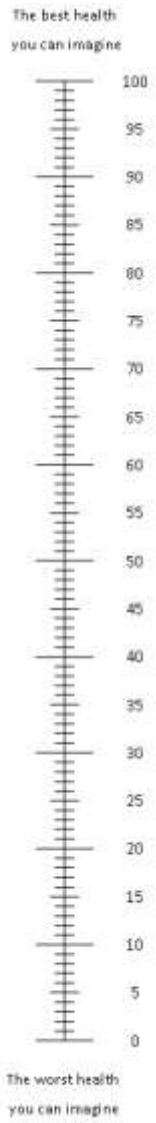
I have no pain or discomfort ☐
I have slight pain or discomfort ☐
I have moderate pain or discomfort ☐
I have severe pain or discomfort ☐
I have extreme pain or discomfort ☐

Anxiety/Depression

I am not anxious or depressed ☐
I am slightly anxious or depressed ☐
I am moderately anxious or depressed ☐
I am severely anxious or depressed ☐
I am extremely anxious or depressed ☐

- We would like to know how good or bad your health is TODAY.
- This scale is numbered from 0 to 100.
- 100 means the best health you can imagine.
  0 means the worst health you can imagine.
- Mark an X on the scale to indicate how your health is TODAY.
- Now, please write the number you marked on the scale in the box below.

YOUR HEALTH TODAY: | N | N | N |



Snot - 22 Questionnaire

INSTRUCTIONS:

Below you will find a list of symptoms and social/emotional consequences of your nasal disorder. We would like to know more about these problems and would appreciate your answering the following questions to the best of your ability. There are no right or wrong answers and only you can provide us with this information. Please rate your problems over the last two weeks.

Considering how severe the problem is when you experience it and how frequently it happens, please rate each item below on how "bad" it is by filling in the box that corresponds to how you feel. *(Fill one box only per item*)

Then, pick the 5 that are the most important items affecting your health and fill in the corresponding box in the grey column on the right.

	No Problem	Very mild	Mild or slight	Moderate	Severe	As bad as it could be	Most important Item (Pick 5)
Need to blow nose	☐	☐	☐	☐	☐	☐	☐
Sneezing	☐	☐	☐	☐	☐	☐	☐
Runny nose	☐	☐	☐	☐	☐	☐	☐
Nasal obstruction	☐	☐	☐	☐	☐	☐	☐
Loss of smell or taste	☐	☐	☐	☐	☐	☐	☐
Cough	☐	☐	☐	☐	☐	☐	☐
Post-nasal discharge	☐	☐	☐	☐	☐	☐	☐
Thick nasal discharge	☐	☐	☐	☐	☐	☐	☐
Ear fullness	☐	☐	☐	☐	☐	☐	☐
Dizziness	☐	☐	☐	☐	☐	☐	☐
Ear Pain	☐	☐	☐	☐	☐	☐	☐
Facial pain/pressure	☐	☐	☐	☐	☐	☐	☐
Difficulty falling asleep	☐	☐	☐	☐	☐	☐	☐
Wake up at night	☐	☐	☐	☐	☐	☐	☐
Lack of good night's sleep	☐	☐	☐	☐	☐	☐	☐
Wake up tired	☐	☐	☐	☐	☐	☐	☐
Fatigue	☐	☐	☐	☐	☐	☐	☐
Reduced productivity	☐	☐	☐	☐	☐	☐	☐
Reduced concentration	☐	☐	☐	☐	☐	☐	☐
Frustrated/restless/irritable	☐	☐	☐	☐	☐	☐	☐
Sad	☐	☐	☐	☐	☐	☐	☐
Embarrassed	☐	☐	☐	☐	☐	☐	☐

Thank you for taking part in this survey

Appendix 2. Unit Cost used in SoCCoR economic analysis

Resource use	Unit Cost 2014	Source
Primary Care Contacts		
GP consultation	£ 46	Unit Costs of Health and Social Care 2014. General Practitioner Unit Costs (Section 10.8b)[22]
GP home visit	£114	Unit Costs of Health and Social Care 2013. General Practitioner Unit Costs (Section 10.8b)[37]
GP telephone consultation	£28	Unit Costs of Health and Social Care 2014. General Practitioner Unit Costs (Section 10.8b) [22]
GP Practice nurse consultation	£13.70	Unit Costs of Health and Social Care 2014. Derived from Nurse - GP Practice (Section 10.6) [22]
GP Practice nurse home visit	£22.03	Unit Costs of Health and Social Care 2014. Derived from Nurse - GP Practice (Section 10.6) [22]
GP Practice nurse telephone consultation	£4.10	Unit Costs of Health and Social Care 2014. Derived from Nurse - GP Practice (Section 10.6) [22]
Secondary Care Contacts		
ENT outpatient attendance	£83	NHS Reference Costs 2013/2014. WF01A Consultant led follow-up attendance (ENT)[23]
Outpatient attendance	£128	NHS Reference Costs 2013/2014. Outpatient - Consultant led[23]
Day hospital visit (CRS-related)	£1533	NHS Reference Costs 2013/14. Weighted average across sinus related day case attendances CA26Z- CA29Z [23]
Day hospital visit (Non-specific)	£698	NHS Reference Costs 2013/14. Weighted average across all day case attendances[23]
Inpatient attendance (ENT ward)	£346	NHS Reference Costs 2013/14. Weighted average across sinus related elective and non-elective excess bed days CA26Z- CA29Z[23]
Inpatient attendance (Non-specific)	£301	NHS Reference Costs 2013/14. Weighted average across all inpatient excess bed days admissions[23]

Appendix 3. Assumptions and Calculation

Cost of productivity loss were derived from assumptions of relevant literature outlined below:

Reference parameters

Parameter	Baseline values	Source
Population 16-24 (2014)	40,389,000	ONS (2014a)[38]
Employment rate (April 2014)	72.9%	ONS (2014a)[38]
Number of working adults in employment (2014)	30,535,000	ONS (2014a)[38]
Hourly rate (£mean)	£15.11	ONS (2014b)[39]
Average hours worked per year (2014)	1531	OECD (2014) [40]
UK Population in 2030	71,400,000	ONS (2011)[41]
Weekly earnings for caring, leisure and other service occupations (median)	£335 per week	ONS (2014b)[42]
Fuel cost – UK Average 2014	116.3 ppl	AA (2014)[21]

Calculations

Parameter	Calculated estimate	Calculation notes
Average daily wage	£ 120.88	= Hourly rate (£mean) * 8 (Eight hour working day assumed)
Average days worked per year	191.37	= Average hours worked per year / 8 (Eight hour working day assumed)
Daily earning for caring, leisure and other service occupation (median)	£47.86	=Weekly rate / 7 (seven working day assumed)

Calculation of CRS cost

Parameter	Assumptions	Source / Calculation
CRS prevalence	11%	Hastan, et al. (2011)[1]
Working age population with CRS in 2014	3,358,850	CRS prevalence x Number of working adults in employment (2014)
Cost of workdays missed due to CRS per year per CRS individual	£236.92 x 4 =**£947.68**	Cost of workdays missed due to CRS per 3 monthly x 4
Cost of workdays missed due to CRS per year	£947.68 x 3,358,850 =**£3.18 billion**	Cost of workdays missed due to CRS per year x Number of working CRS adults
Overall healthcare cost of CRS for 2014	11% x 40,389,000 x £4844.88 =**£21.5 billion**	CRS prevalence x Population x Estimated annual average cost of CRS
Overall incremental cost of CRS for 2014	11% x 40,389,000 x £3782.44 =**£16.8 billion**	CRS prevalence x Population x Estimated annual average incremental cost of CRS