



# **The lifetime costs of attention deficit hyperactivity disorder (ADHD)**

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# 1 INTRODUCTION

Attention deficit hyperactivity disorder (ADHD) is one of the more prevalent forms of neurobehavioral disorders that may be diagnosed in childhood. ADHD is characteristically comprised of three main “pervasive and impairing” components: inattentiveness, hyperactivity and impulsiveness (Polanczyk, de Lima et al. 2007). In the available literature, most studies rely on two standard screening criteria for the diagnosis of ADHD: The DSM-IV-TR (Association 2000), primarily captures ADHD while conversely, the ICD-10 (Organization 1992) identifies individuals with “Hyperkinetic Disorder”. While they are both fundamentally descriptors of the same disorder, the difference lies in the weightings placed on the various components of the screening methodology (Swanson, Sergeant et al. 1998). One of the critical specifications of the ICD-10 measurement requires that all three characteristics to be present in the individual. On the other hand, the DSM-IV is “divided into cases where this is so called ‘Combined type’ - those where only inattentiveness, or only overactivity and impulsiveness, are present” (Rutter, Bishop et al. 2011).

Globally, the prevalence rate for the disorder has been estimated to be roughly 5.3% (Polanczyk, de Lima et al. 2007) while in the UK, the prevalence rate of ADHD for 5-16 year olds has been found to be 2.6% for boys and 0.4% for girls (Green 2005). Children diagnosed with ADHD are often considered at a disadvantage in “sustained attention, impulse control, and modulation of activity level” (Pelham, Foster et al. 2007) and while hyperactivity is often diagnosed at early stages of an individual’s youth, it tends to present and persist itself in numerous social spheres (Friedman, Rapport et al. 2003). Furthermore, issues related to ADHD not only affect the individual child, but have also been demonstrated to have consequences on both the family and peers, as well as members of society such as taxpayers. Unfortunately, the detriments of ADHD do not simply disappear beyond an individual’s youth. Often, these deficiencies in day-to-day activities persevere through to adolescence and even adulthood (Mannuzza and Klein 2000) with rates of adolescent-adulthood persistence (based on DSM-IV definitions) to be around 65% (Faraone, Biederman et al. 2006). While they may cause the individual mental suffering and hindrance, it is a disorder that is also considered to be pervasive and its effect on one’s quality of life is reflected in several areas such as education, social interaction, and employment (Le, Hodgkins et al. 2013). Additionally, ADHD is often co-occurring with several other disorders such as oppositional defiant disorder, conduct disorder and anxiety disorder (Jensen, Hinshaw et al. 2001) and studies have highlighted the need for disentanglement when considering the primary effects of ADHD (Rothenberger, Banaschewski et al. 2000).

Typical characteristics of ADHD are commonly identified at early stages of childhood, and a large proportion of cases are diagnosed in children around the period when they begin schooling. Given that a large proportion of individuals diagnosed with ADHD are identified in childhood, there is a strong effect of ADHD on the service use of youths and often, this has strong implications on the education and childhood healthcare outcomes of the individual. The nature of the disorder, disease treatments and outcomes are the most prevalent area in the literature where ADHD is broadly discussed. Different forms of intervention and treatments over the years for the mental health disorder have allowed for a variety of literature to develop in terms of the psychopathology, medication and clinical outcomes of ADHD disorder. There is a rich amount of information available for the clinical aspect of ADHD, both in the primary care environment, as well as medication involved with treatment and treatment interventions themselves. From an education perspective, children suffering from ADHD often require extra attention from teachers and longer hours, as well as the potential need to repeat an academic year. This not only affects the individual, but also has social implications since teachers shift more of their attention towards those with difficulties and therefore other students are put at a disadvantage in the class, often grading poorly with low reading and math scores, as well as increased likelihood of grade retention, utilising more education services than the typical student (Loe and Feldman 2007).

There is a divide in the literature between both methodologies, with several papers relying on the ICD-10 criteria while others focus on a DSM-IV approach. In a few cases, both ICD-10 and DSM-IV approaches have been utilised. However, this difference in screening has created inconsistency between empirical results. As the ICD-10 requires the patient to test for all three ADHD characteristics, it intuitively suggests that those diagnosed using these criteria would have more symptoms and therefore more difficulties compared to those screened under DSM-IV criteria. In turn, empirical evidence based upon ICD-10 measurements may be found to have higher results, as well as more severe presentations compared to the DSM-IV counterpart that we shall discuss below.

While there have been “hundreds of papers, reviews, and texts have focused on the diagnosis, aetiology, psychopathology, presentation, treatment, and outcome of the condition over the last three decades” (Pelham, Foster et al. 2007), there is a lack of evidence on the economic outcomes and cost of illness related to those suffering from ADHD. This is remarkable given the abundant literature on cost of illness for other physical disorders. Only in recent years has the economic consequences of ADHD been looked into and often, it has only been through a specific lens such as delinquency, healthcare utilisation or education. Furthermore, while we are aware of the long-term effects of ADHD that presents itself through to adolescence and adulthood, none (as far as I am aware) have attempted to take consideration of the economic costs over an individual’s lifetime.

Several papers have looked into the various perspectives that can be taken when looking at the economic outcomes of ADHD and besides the individual themselves, implications on family members have also been studied (Birnbaum, Kessler et al. 2005) with evidence highlighting the burden on parents' occupation and sibling development (Harpin 2005) though these studies have not estimated the total costs.

Given this evidence, there seems to be an opening to develop a greater understanding of the economic costs of ADHD in terms of its effect on society and in turn, it's implications for how policymakers should allocate their resources in the most efficient manner. The most ideal method to answer this would be through a cost of illness study to provide grounds for improved interventions and potentially preventative measures for individuals suffering from ADHD. This dissertation aims to compile a broad estimate of the total economic impact of ADHD to society over the course of the lifetime of a typical-case individual suffering from ADHD. Through a thorough review of the established literature, a cost of illness will be derived for the economic consequences of ADHD from a societal perspective over the course of a patient's lifetime. A discussion of the limitations and assumptions will follow the discussion of the resultant findings and I shall conclude by highlighting the implications for social policy as well as the requirements of future research regarding this area of mental health.

## **2 METHODOLOGY**

### **2.1 Framework for Cost of Illness**

When considering the total costs associated with a disorder, one must consider the distinction between tangible and intangible costs (Pelham, Foster et al. 2007). With regards to tangible costs, Cost of Illness studies are more reflective of the evident outcomes of an illness while conversely, Willingness to Pay studies are able to incorporate more intangible issues such as pain, suffering and quality of life. An example of this distinction would be the cost of violence - in particular, rape - through the two views (Cook and Ludwig 2000). A Cost of Illness study would yield a result reflective of the relevant medical expenses and lost income of the victim, as well as the costs of imprisonment for the criminal. On the other hand intangible cost estimates would include factors such as the pain and suffering related to experiencing such a crime. In most comparative reports, Willingness to Pay estimates are relatively higher compared to Cost of Illness measures. This is intuitive given the incorporation of the intangible effects in a Willingness to Pay analysis.

While it would be beneficial to estimate intangible effects such as quality of life (as it allows us to capture a fuller effect) there are a few limitations in how it is currently undertaken in Willingness to Pay estimates which raises concerns, especially when dealing with an illness that is related to mental health. Intangible costs derived from Willingness to Pay results are usually based on individuals personal feelings and biases, rather than absolute costs. Empirical evidence has pointed to the fact that individuals do not have perfect information on their preferences and choices (Dolan, Layard et al. 2011) and therefore, self-reports of this nature are subjectively flawed. Additionally, self-reports commonly used in Willingness to Pay reports are often subject to biases, framing and contextual nudges of questions, reducing the robustness of results. These issues are magnified when evaluating a mental health illness since self-reports tend to understate the potential consequences of the disorder (Dolan and Metcalfe 2012) in comparison to physical ailments.

Ideally, the incorporation of intangible costs into our evaluation would be useful. However, the current limitations in quantifying intangible costs (such as quality of life) are highly apparent. Hence, the analysis presented in this dissertation focuses on the tangible costs related to ADHD and will therefore undertake the standard Cost of Illness approach. Cost of Illness is a common framework in the literature and has been utilised for various medical cost evaluation such as drug use, asthma and depression (Berto, D'Ilario et al. 2000, Ernst and Grizzle 2000, Weiss, Sullivan et al. 2000).

## 2.2 Study Considerations

There are three important aspects to consider when developing a Cost of Illness study: the perspective of the analysis, the categorical costs to be incorporated, and the time period to be examined. The initial consideration is the perspective of the analysis and which party we shall focus on in the dissertation. This is crucial since 'the value of an input used in delivering a program may depend on the perspective from which that value is assessed' (Pelham, Foster et al. 2007). A theoretical example would be if parents of an injured adolescent have to take time off to take them to the hospital. From the perspective of the healthcare provider, the costs considered are the reflective of the unit and service costs spent on treating the individual. A wider, societal perspective may consider the lost income or hours forfeited by the parent for having to take their child to the hospital while the individual costs would be the user charges as well as potentially lost wages if they are working. Hence the focus for this dissertation will be based upon a societal perspective. While an individual or governmental approach would have been similarly suitable, there are limitations in the current literature and data that we have available which would restrict the completeness of the analysis. Additionally, no papers have considered the lifetime societal cost of

an individual for ADHD and by taking this perspective; we have the ability to consider implications to policy decisions.

In an attempt to best express a societal perspective, our analysis has included the costs to healthcare providers, the education system as well as income loss and differences in employment outcomes. While cost of crime has been included in our analysis and discussion, the results found gave little evidence to support an inclusion of crime into the cost of illness extrapolation. While there are certainly indirect effects associated with a mental disorder such as ADHD, it has been highlighted that there is a lack of “data currently available that quantify and enable monetisation” for wider perspective such as families - “parental work loss, parental stress-related illnesses, and increased childcare expenses” (Pelham, Foster et al. 2007), which we shall expand upon further in our limitations below.

Our second concern is the categorical sectors within the analysis “health-sector costs, productivity-related costs, and other costs, such as costs borne by other public systems (e.g., education and juvenile justice)” (Pelham, Foster et al. 2007). Since the perspective of this analysis will be that of a societal perspective, this dissertation will attempt to cover and quantify the main channels of healthcare, employment, education and crime. Through the Cost of Illness analysis, we are able to capture the costs to society through expenditure on mental health disorders, on the education system, the potential costs of unemployment/lost income and finally, the expected cost of crime associated with those suffering from ADHD. While most papers have discussed each of these aspects independently, few have attempted to aggregate the total costs to society, and certainly not for a British setting. This is surprising given the breadth of effect ADHD has on various aspects of government expenditure and it raises concern that the true cost of illness for the disorder has been severely understated as well as the value of early interventions. Finally, the last piece of a cost of illness study requires definition of the time period involved. Many studies in the field of ADHD estimate cost of illness over the year of study while few have considered the economic impact over the course of an individual’s lifetime. This is fairly crucial to consider in our analysis since one of the more pertinent issues with ADHD lies in the chronic nature of the disorder. This has significance in our analysis since there are potential costs that extend beyond childhood, which can be potentially captured in a study. However, this in turn raises the issue of time discounting and adapting future costs of an individual to be suitably consistent to prices of today. Given this argument, this dissertation attempts to capture the costs of ADHD over the lifetime of an individual - incorporating data on ADHD costs for youth, adolescents and adults. Through a thorough review of the relevant literature, a comprehensive value of annual costs can be derived for the youth and



adult groups and in turn, we are able to project the expected societal cost over the course of an individual's lifetime with ADHD.

## 2.3 Literature Search

Several databases (PubMed, ERIC, HEED, and PsycINFO) were utilised to identify English written papers published between January 1, 2003 and August 1, 2014. Search terms were based on cases relating to ADHD or Hyperkinetic Disorder and in particular, the categorical outcomes (crime, education, healthcare, employment) or quantified societal costs that focused on youth, adolescents or adults. Articles regarding the clinical outcomes of ADHD medication were ruled out since these analyses have been shown to have dealt with more payer-only perspectives (Beecham 2014) which is inconsistent to the purposes of this dissertation. An initial search yielded roughly 16,200 results irrespective of potential duplicates. A secondary screening involved manually reviewing abstracts and citations and determining relevance to the objective of the dissertation. Papers retained were those that were established as original research in a European or North American environment, focusing on the quantitative cost of ADHD patients and relevant outcome categories. This was done predominantly through two means: either a study examining the absolute costs to the ADHD sufferer, or the relative difference between an ADHD case and a control case, depending on the type of outcome involved. Consistent with the literature (Le, Hodgkins et al. 2013), studies were limited to original research that was peer-reviewed - "meta-analyses, case studies, editorials, opinion papers, and review articles" were eliminated from the pool of results. After all screening and eliminations, the number of articles used to quantify cost data in this dissertation was finalised (n=16) which comprised of five British Studies, five North American Studies and six European Studies. An evaluation of the findings within these studies is summarised in the Appendix (See: Appendix, A1) and will be discussed in detail within the individual categorical analyses below.

## 2.4 Extrapolation & Projection of Cost Data

Available costs from the selected studies that succeeded past the screening process were extrapolated for use in the dissertation. While our analysis evaluates the obtainable literature through four categorical costs, the results and limitations of the available data meant that only healthcare utilisation, education and employment costs were extrapolated for our cost-of illness estimates. These were used to generate the projected, base costs of an individual sufferer of ADHD, from a societal perspective (See: Appendix, A2, A3, A4). Crime was not included in the final cost estimation due to the large body of evidence suggesting that conduct disorder rather than ADHD was a large proponent of crime related costs for individuals. The extrapolation was unable to

account for differences in study standards between papers, as well as any original discrepancies within the individual papers - for example, statistical restrictions due to small sample sizes.

Cost data has been derived from the available papers analysed in this dissertation and all values have been converted into British Pounds (£) using 2012/2013 values as the base year. Average estimates of the categorical costs have been derived from the available papers. Conversion rates to British Pounds are based on purchase power parity rates from Organisation for Economic Co-operation and Development data (OECD 2014) while conversion values for 2012/2013 have been derived from PSSRU Unit Costs of Health & Social Care 2013 (PSSRU 2013). Additionally, the lowest and highest costs per classification were highlighted and used to generate high-projection and low-projection rates for overall costs.

Several assumptions have been made regarding the time period of the categorical costs. We presume that diagnosis occurs at five years old, the time when most children begin education and often when a diagnosis is made. Given our knowledge on the persistency of the disorder into adulthood (and from the data, that healthcare costs do not fluctuate over the years), we have assumed that healthcare utilisation occurs from ages 5-50 years old. We assume that children finish at least higher education and therefore education costs are projected from the ages of 5-20 years old. While there is no compulsory retirement age in the UK, we have assumed that individuals are employable between the ages of 20-50 years old.

The base discount rate is derived from the Public Sector Discount Rate for the UK (Treasury 2003) which is currently set at 3.5% per annum in real terms. However, we have also accounted for the rise of wages, healthcare and education costs, taking these to rise at 1% faster than general inflation. Hence, the annual discount rate incorporated into our analysis is 2.5%.

## **3 RESULTS**

### **3.1 Findings on the Effects of ADHD on Cost of Healthcare**

Given the nature of the analysis, there is a vast amount of available data and literature on the costs and outcomes of ADHD sufferers. A large proportion of the available literature has been based on UK and European samples, which has been beneficial when trying to adapt costs which most accurately reflect the expenses to the average British individual diagnosed with ADHD. Five papers have been utilised for the purposes of this dissertation - four based on British samples, and one focused on Dutch outcomes. While these papers have considered the total costs of healthcare to the

average individual diagnosed with ADHD, the breakdown and derivation of these costs varies greatly. Additionally, the ADHD screening criteria have been mixed amongst the studies. Finally, studies have tended to highlight the healthcare utilisations of ADHD individuals only with few determining the expected costs for a controlled group of patients (individuals free of ADHD diagnosis).

The study undertaken by Telford, Green et al. is based on a British sample of adolescents (12-18 years old) who have been diagnosed with ADHD through the Cardiff longitudinal ADHD study. While the study itself did not mention the specific screening methodology, other papers that have utilised the dataset have highlighted consistency with DSM-IV criteria (Langley, Fowler et al. 2010). The study divides healthcare utilisation costs into two main categories: Medication costs (Based on results from the British National Formulary, 2010) for stimulant and non-stimulant consumption, and NHS Healthcare costs (based on UK national sources) which comprised of services such as psychologist and paediatrician visits. The total annual cost of medical expenses was found to be £1310.02 in 2010 prices of which, NHS healthcare was found to total £657.94 and Medication costs were £652.08.

Snell, Knapp et al. undertook cost extrapolations for a British sample of 5-15 year olds based on the British Child and Adolescent Mental Health Surveys. ADHD screening criteria in the report was based on assessments through the Development and Well-being Assessment (DAWBA) that were reflective of a mixture of ICD-10 and DSM-IV methodologies. Healthcare utilisation costs were divided into primary care (such as GP visits), paediatric/children's healthcare (paediatricians, school nurses and A&E visitations), and mental health services (child psychiatrists, family therapists) and were valued based on the Personal Social Services Research Unit annual handbook, or if unavailable, were inflated from previous years data. Based on 2007/2008 price index, the annual cost of healthcare utilisation was totaled at £268.80 of which, Primary care amounted to £15.34, Children's Healthcare amounted to £69.70, and the cost of Mental Health Services was totaled to £183.76.

The D'Amico, Knapp et al. study was able to compare a sample of 24 boys diagnosed with Hyperactivity, compared with and a group of 25 boys as a control while also taking into account issues of conduct disorder. ADHD screening criteria were derived through 'high hyperactivity and conduct problem scores' and the study made no reference to its consistency with ICD-10 or DSM-IV measures, which have been the typical criteria used by most of the other papers. Healthcare utilisation costs were based on NHS reference costs in 2009/2010 while "unit costs for GP visits, nurse consultations, counseling and social care support were taken from the Personal Social

Services Research Unit (PSSRU) volume for 2010” (D’Amico, Knapp et al. 2014). The study found an annual cost of £1563 for the control group and £2099 for the ADHD group in 2010 prices.

An extensive study was able to compare the costs of individuals diagnosed with ADHD, and a control group with no history of ADHD (Holden, Jenkins-Jones et al. 2013). The study gathered data from 1998 to 2010 based on individuals above the age of six years old. Diagnosis patients with ADHD from the UK Clinical Practice Research Datalink, with controls were drawn based on not having any ADHD diagnosis. ADHD screening criteria was based on whether individuals had “received two or more diagnoses for ADHD in their clinical history”. Alternatively, patients would be selected if they “received at least one diagnosis of ADHD and at least one prescription for a medicine licensed for the management of ADHD” (Holden, Jenkins-Jones et al. 2013) with diagnoses undertaken based on NICE guidelines which advocates use of ICD-10 or DSM-IV methodologies - though this is not explicitly stated in the report itself. While healthcare costs were not divided into subgroups, the costs were aggregated based on “prescriptions, primary-care contacts, investigations, hospital admissions, and outpatient appointments” and were based on a 2010 index. Additionally, the study differentiated healthcare costs of different patients by two age groups: 6-17 years old, and 18 years old and above. The yearly costs for patients initial five years after the index date were extrapolated. The report found healthcare costs to be positively skewed amongst the sampled population. The average annual cost over the years for all year groups was found to be (ADHD versus Control): £1,327 versus £328 for year 1, £1,196 vs. £337 for year 2, £1,148 vs. £316 for year 3, £1,126 vs. £325 for year 4, and £1,112 vs. £361 for year 5 (Holden, Jenkins-Jones et al. 2013). However, the median values were found to be £890 vs. £69 for year 1, £770 vs. £65 for year 2, £735 vs. £64 for year 3, £673 vs. £64 for year 4, and £632 vs. £65 for year 5. Values remained largely consistent between adolescent and adult healthcare costs which gives rise to the assumption that while costs of ADHD may persist from adolescence into adulthood, the value of these costs do not differ by a significant proportion.

Only one European study was evaluated outside of the UK, which undertaken in the Netherlands (Hakkaart-van Roijen, Zwirs et al. 2007). The study was based on a sample of 70 children who were treated for ADHD based on a DSM-IV screening methodology while controls were taken from the Dutch ADEON study, identifying children with low scores for behavioural problems. Medical costs were based on a ‘bottom-up methodology’ and were based on 2004 prices. Based on the study, the annual healthcare costs for ADHD patients was found to be €1173<sup>1</sup>, and €177 for the control group.

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<sup>1</sup> The value given for the ADHD group excludes one individual who positively skewed the results due to their 84-day admission to a psychiatric hospital’ (Hakkaart-van Roijen, Zwirs et al. 2007).

Healthcare utilisation results have been extrapolated from the data and presented in Table 1. The average annual cost of healthcare was found to be £920.37.

**Table 1**

Study	Country	Estimated Total Cost in GBP (£) for 2012/2013 <sup>2</sup>
Telford, C., Green, C., Logan, S., Langley, K., Thapar, A., & Ford, T.	UK	1,410.00
Holden, S. E., Jenkins-Jones, S., Poole, C. D., Morgan, C. L., Coghill, D., & Currie, C. J.	UK	1,240.86
Snell, T., Knapp, M., Healey, A., Guglani, S., Evans Lacko, S., Fernandez, J. L., ... & Ford, T.	UK	311.09
D'Amico, F., Knapp, M., Beecham, J., Sandberg, S., Taylor, E., & Sayal, K.	UK	576.91
Hakkaart-van Roijen, L., Zwirs, B. W. C., Bouwmans, C., Tan, S. S., Schulpen, T. W. J., Vlasveld, L., & Buitelaar, J. K.	Netherlands	1,062.97

### 3.2 Discussion of Healthcare Utilisation

Based on the available literature, it is apparent that there is a significant cost from the healthcare utilisation of ADHD patients. From the results of our extrapolation (See: Appendix, A2), all studies have pointed to medical expenses having a large impact on ADHD individuals and in turn, this is a cost that is predominantly borne on the public sector in the UK.

While the literature reviewed points strongly to additional costs, there is a large variety in the magnitude of the costs associated with treating an ADHD patient. From our extrapolated results, the annual mean cost for an individual patient has ranged from £311.09 to as high as £1,410.00 in 2012/2013 prices. This can be attributed to several structural reasons. Firstly, there is a large variability in what papers have classified as an important 'medical cost' to the ADHD individual. As highlighted in the results above, papers are divided in how they group different medical costs, if they are even grouped at all. This lack of consistency between papers - even those that have been conducted within the same country - creates a lot of conflicting values for healthcare costs. Additionally, an inherent problem within many of the studies presented is the inconsistency of how

<sup>2</sup> Green highlights are values used for High estimations while Red highlights are values used for Low estimations.

ADHD may be diagnosed. As mentioned previously, there are two standard methodologies in screening for ADHD: DSM-IV and ICD-10. While both are essentially measuring the same disorder, there is a distinction between the two criteria where ICD-10 screens for all three subtypes of ADHD. Hence, many diagnoses under ICD-10 criteria are more severe and by reason, should utilise higher healthcare costs. Conversely, studies that have been based on DSM-IV methodologies have found lower healthcare cost burdens, which is intuitive since many of the diagnoses exhibit milder symptoms. This screening inconsistency is magnified when considering a fundamental issue in healthcare where a “relatively small group of individuals account for a large fraction of spending” (Stanton 2006). This has also been the case in the results found in the dissertation - in one study, the impact of one patient was able to affect the mean annual cost by almost 50 percentage points (Hakkaart-van Roijen, Zwirs et al. 2007). This raises concerns on whether the mean annual cost is the most reliable source of costing to utilise in the study, but in certain cases, the median values were not available. When considering this issue in addition to the added severity of cases in ICD-10 diagnosis, it is understandable how there has been a large difference in the absolute costs associated with healthcare utilisation.

### 3.3 Findings of ADHD on Educational Costs & Outcomes

The direct cost of ADHD on education is apparent from our results. From the available literature, education costs clearly make up the largest proportion of total costs from a societal perspective. The sizeable costs due to education are reflective of policy reactions to ADHD consequences. In the UK, children who are clinically diagnosed with ADHD are often entitled to special education benefits through The Equality Act 2010 (Act 2010). This is usually fulfilled through Special Educational Needs (SEN) for primary and secondary education and Disabled Students' Allowances (DSA) for higher education. The main variations in costs tend to depend on whether a child is attending a mainstream school that accounts for special needs, or if a child attends a specialist school. Another important aspect to consider here is the indirect effect of education on other measured outcomes. Studies have highlighted correlations between ADHD and education outcomes - which have indirect implications on areas such as crime, and future employment.

Of the available literature, two reports were found that determined the total costs of education for ADHD sufferers in a British environment and one report based on an American dataset. Telford, Green et al. considered the educational costs of children from ages 12-18, utilising data from the Cardiff Longitudinal ADHD Study. The annual utilisation of mental health services was derived through interview and were incorporated into unit cost data to generate costs per individual patients and the average cost per patient (Telford, Green et al. 2013). The annual cost of education was

found to be £4,155.03 (£3,152.05, £5,326.26 95% CF) at 2010 prices, for the average child. Another British study was undertaken by Snell, Knapp et al. based on the British Child and Adolescent Mental Health Surveys, a representative sample of 5-15 year olds in the UK. The dataset was used in combination with national unit cost data to assess the economic impact of ADHD on public sector costs. Cost data was extrapolated through the Education Cost Statistics by the Chartered Institute for Public Finance and Accountancy. The study was able to compare cost burden of ADHD to conduct disorder and emotional disorder. The average annual cost was found to be £2725.11 in 2008 prices for a child suffering from ADHD. Of note, the cost of education was found to be the largest proportion of cost for the public sector in this analysis. Comparatively, Robb, Pelham et al. was an American based study assessing the differences in educational costs between Pittsburgh youth suffering from ADHD, and a control group. Educational costs for this study were derived from United States Department of Education, Special Education Expenditure Project (Chambers, Shkolnik et al. 2003). The average student suffering from ADHD was found to have cost society \$5,007 in 2010 prices, while students in the control group were found to cost \$318 from an educational perspective.

Education cost results have been extrapolated from the data and presented in Table 2. The average annual cost due to education was found to be £3,839.79.

**Table 2**

<b>Study</b>	<b>Country</b>	<b>Estimated Total Cost in GBP (£) for 2012/2013<sup>3</sup></b>
Telford, C., Green, C., Logan, S., Langley, K., Thapar, A., & Ford, T.	UK	4,472.15
Snell, T., Knapp, M., Healey, A., Guglani, S., Evans Lacko, S., Fernandez, J. L., ... & Ford, T.	UK	3,153.84
Robb, J. A., Sibley, M. H., Pelham Jr, W. E., Foster, E. M., Molina, B. S., Gnagy, E. M., & Kuriyan, A. B	USA	3,893.38

When considering how ADHD might indirectly influence outcomes linked to education, two studies were available (one British, one North American) which considered the indirect effects of ADHD and education and how this could affect future likelihood of criminality, and future employment outcomes respectively.

<sup>3</sup> Green highlights are values used for High estimations while Red highlights are values used for Low estimations.

Behnken, Abraham et al. American study found that the expected value of standardised test scores was noticeably higher for youths that were not diagnosed with ADHD. In turn, this indirectly forecasted better probabilities in attending higher education that indirectly affected likelihood outcomes for future criminal activity. A study was undertaken to consider the effect of an ADHD diagnosis on the GCSE results of students in a British sample (Birchwood and Daley 2012). Similar to Behnken, Abraham et al., ADHD diagnosis was a strong predictor of an individual's educational outcomes, with controls scoring higher in GCSE's compared to those diagnosed with ADHD. This had an indirect effect on motivation and cognitive ability, which itself affected employment opportunities and future outcomes of individuals.

### 3.4 Discussion of Educational Costs & Outcome

The results of the available studies considered in this dissertation have all pointed towards a significantly higher cost of education for individuals diagnosed with ADHD, compared to control individuals, which is consistent with the findings of other literature (Matza, Paramore et al. 2005). This follows conventional wisdom since most patients that have been diagnosed with ADHD require extra academic requirements compared to the average child, such as extra contact hours, special classes, or even non-mainstream education altogether, in order to try and keep them on the same level as non-ADHD students. Of the four domains considered, education carries the largest burden from both an annual and lifetime standpoint (discussed in more detail below). Despite the timeframe lasting until an individual finishes their education - when they transition from an adolescent to an adult - they remain the highest burden when considering costs from a lifetime perspective. Most papers are fairly consistent with the expected value of added costs for an ADHD individual when values have been converted and inflated to 2012/2013 prices (See: Appendix, A3). Differences between cost identification methodologies are largely accredited to the small variations between the costs. Looking at international comparisons, results are also found to be largely consistent with each other.

A strong rationale behind the higher costs in Telford, Green et al. compared to Snell, Knapp et al. is the fact that Snell, Knapp et al. have accounted for conduct disorder in their analysis. While Telford, Green et al. have accounted for several confounders; conduct disorder has not been reported in the analysis. From our results in crime, conduct disorder has the potential to generate high costs to different areas of society, and this may certainly be the case in the education costs. Furthermore, conduct disorder has often been associated with ADHD when individuals are diagnosed. However, the extent of the individual effect due to each disorder is still being researched. However, this does implicate some of the variations of the presented results.



Our evaluation also included an analysis of the impact of ADHD on educational outcomes and the indirect effects on other sectors due to education. While we were limited in the amount of papers available in this area (and no papers were able to quantify financially indirect effects), the two papers obtainable have highlighted lower educational outcomes for ADHD sufferers compared to non-ADHD controls - this is a finding that was consistent in both our British study (Birchwood and Daley 2012) and American Study (Behnken, Abraham et al. 2014). From an empirical standpoint, it is difficult to quantify - even more difficult financially - the repercussions of indirect effects of education given that there are many variables that operate which would affect our estimation. Nonetheless, there is certainly some effect which must be acknowledged and which shall be discussed further in policy implications.

### 3.5 Findings on the Direct Effects of ADHD on Employment

While the general consensus is that there is a detrimental effect to employment prospects and income with the diagnosis of ADHD, there is mixed evidence regarding the degree of severity of effect on the individual. From the available literature, four papers have been found regarding the correlations of ADHD and employment - two from Norway (based on ICD-10 criteria) and two from the USA (using DSM-IV screenings).

Of the two Norwegian papers, Halmøy, Fasmer et al. sampled an adult population (aged 18 years old and over) of individuals suffering from ADHD. The sample drew patients from all parts of Norway - with participants reviewing previous and current symptoms of ADHD - and was compared with a control based on the Medical Birth Registry of Norway (MBRN). The results found a 50-percentage point difference in employment rates between ADHD and control groups. However, it was found that ADHD interventions were associated with higher probabilities of being in work, especially stimulant therapy undertaken in childhood. These results were largely consistent with Gjervan, Torgersen et al., which sampled from the Patient Administrative System at Levanger and Namsos hospitals in North-Troendelag, Central Norway (Gjervan, Torgersen et al. 2012). The report found the difference between employment rates for ADHD and controls to be around 57 percentage points.

The Norwegian studies contrasted in results compared to the American results in employment outcomes with ADHD. Klein, Mannuzza et al. American study on youth (mean study age group was 8 years) with ADHD but who were free from conduct disorder (Klein, Mannuzza et al. 2012). The study included a 33-year follow-up and was able to consider several aspect of an individual's social life. In terms of employment outcomes, the study found ADHD individuals to have worse occupational attainments compared to controls. Difference in employment rates been ADHD and

Controls was 11.2% while the median difference between the groups (ADHD: \$60,000 & Controls: \$100,000) was \$40,000. Results from Biederman & Faraone found that there was a 25.1 percentage point difference in full-time employment rates between ADHD patients and controls. The significant difference in employment rates was maintained even when comparing by academic achievement, with ADHD sufferers having lower rates of employment at all levels of final academic achievement. Additionally, the study considers the differences in income attainment of ADHD and controls. There was found to be significant differences overall between the ADHD (\$41,511) & Control (\$52,053) groups with a gap of \$10,542. Results remained significant when comparing by gender - differences in males was found to be \$8,754 (19.17%) higher for controls, whereas for females, the difference was \$12,131 (32.26%). The report estimates the ‘annual income change per person attributed to ADHD’ (Biederman and Faraone 2006) and based on the study, the annual loss in income was found for the basic and advanced models<sup>4</sup> to be \$8,900 and \$10,300 in 2003 prices respectively. The study advises use of the advanced model of results when considering the differences in income level between ADHD and controls.

Income loss results have been extrapolated from the data and presented in Table 3. Unfortunately there was a lack of data from the Norwegian studies on income losses. Hence, the average annual income loss of £2,650.28 was based on the American data results.

**Table 3**

<b>Study</b>	<b>Country</b>	<b>Expected Loss of Income in GBP (£) for 2012/2013<sup>5</sup></b>
Halmøy, A., Fasmer, O. B., Gillberg, C., & Haavik, J.	Norway	
Gjervan, B., Torgersen, T., Rasmussen, K., & Nordahl, H. M.	Norway	
Klein, R. G., Mannuzza, S., Olazagasti, M. A. R., Roizen, E., Hutchison, J. A., Lashua, E. C., & Castellanos, F. X.	USA	3,386.69
Biederman, J., & Faraone, S. V.	USA	1,913.88

<sup>4</sup> The advanced differs from the basic model in that we assume “observed differences in educational attainment and performance between the ADHD and control groups are fully related to ADHD”, hence the reason the advanced models produce consistently higher results.

<sup>5</sup> Green highlights are values used for High estimations while Red highlights are values used for Low estimations.

### 3.6 Discussion of Employment and ADHD

Given the results of the literature findings and extrapolation (See: Appendix, A4), there is no doubt that there is a significant difference in employment outcomes and income attainment between ADHD and non-ADHD individuals. All papers examined have re-iterated the stance that individuals suffering from ADHD are generally expected to have worse employment outcomes and additionally, lower income earnings compared to non-ADHD counterparts. One of the potential reasons for this is the indirect effect of education and how outcomes in the academic sector create long-term disadvantages, which then has effects on individuals' future employment and earnings.

However, the literature is divided on the magnitude of effect ADHD has on employment and earnings. The European studies have highlighted a gap of around 50% between ADHD and non-ADHD individuals, while American studies have reported figures between 11-25%. The main rationale behind this is the difference in ADHD diagnosis methodologies between countries - and argument that has been consistent within other areas of our discussion - Halmøy, Fasmer et al. have attributed the divide between European and American rates to “differences in social welfare policies” as well as “differences in diagnostic assessments and thresholds in diagnosing ADHD” which has been observed for the differences in international prevalence rates for ADHD (Heiervang, Stormark et al. 2007). Additionally, “a considerable fraction of children diagnosed with ADHD recover from the symptoms as adults”(Halmøy, Fasmer et al. 2009), ADHD patients with more severe symptoms are less likely to recover completely. This divergence coupled with a lack of evidence from a British setting has caused extrapolation to be rather problematic - while we have taken the more conservative estimates based on the American studies, more research should be undertaken in the UK to generate some base estimates for employment and income losses.

While there was an attempt to consider the indirect employment effects due to ADHD, only one paper in the literature (Hakkaart-van Roijen, Zwirs et al. 2007) was able to consider this in the form of productivity loss and absenteeism for mothers of children with ADHD. While there were limitations in the data presented, it does raise the issue of indirect effects on family members due to ADHD. It underlines the fact that despite best efforts to capture a full array of societal costs, the total cost of illness results would still be undervalued due to the limitations of indirect effect. Further consideration on this matter shall be addressed further in future research recommendations.

### 3.7 Effect of ADHD on Crime

For the purposes of this dissertation, the effect of ADHD was examined on the likelihood of childhood delinquency, adult criminality and recidivism. Six papers written in the last ten years were found from the available literature with results from Germany, Iceland, Norway, Canada, USA

and UK. While conventional theory in the literature points to ADHD causing an effect on the likelihood of crime (Moffitt 1990), more recent studies have understood the need to disentangle the effects of ADHD and other behavioural disorders (especially ones such as conduct disorder) in order to better understand the true effects of ADHD on societal costs (Bernfort, Nordfeldt et al. 2008). This is particularly important in the area of crime given the substantial evidence of Conduct Disorder affecting child delinquency and future criminal convictions (Hodgins, Cree et al. 2008). From the available literature that accounted for conduct disorder when analysing ADHD diagnosis and criminal outcomes, the majority of the evidence found ADHD to be a weak predictor of future criminal activity in individuals. Except for one study (D'Amico, Knapp et al. 2014), all others remained consistent in their ADHD screening criteria, utilising either ICD-10, DSM-IV or a methodology reflective and consistent with either standard.

Of the six papers examined, Grieger, L., & Hosser, D. report was the only paper that found strong effects of ADHD diagnosis in youth and criminal outcomes in adulthood while controlling for conduct disorder and substance abuse (Grieger and Hosser 2012). ADHD diagnosis was found on DSM-IV controlled self-reports on a sample of German inmates based on their childhood experiences. It was found that over 50% of the interviewed inmates passed the screening criteria for childhood ADHD. However, despite this, the paper found no causal effects between ADHD and recidivism of inmates - those that were diagnosed with ADHD were not more likely to commit a re-offence compared to other inmates in the baseline results. It is interesting to note that the results of Grieger, L., & Hosser, D. were found to be consistent with earlier work involving ADHD and likelihood of criminality (Bulten, Nijman et al. 2009). However, one of the limitations highlighted in previous research is the lack of control for co-morbid factors such as conduct disorder or other behavioural illnesses. A restriction raised in the results from Bulten, Nijman et al. was the potential bias due to the lack of "collateral information from parents and school teachers", coupled with the nature of self-reporting methodologies for mental health patients, which may have incorrectly identified ADHD instead of other behavioural disorders. This will be elaborated in the discussion.

Nonetheless, all other recent papers that have controlled for conduct disorder/aggression behaviour have been consistent in their results: ADHD diagnosis lacks direct association with future criminal outcomes. Mordre, Groholt et al. considered the effect of ADHD on criminality in Norway (Mordre, Groholt et al. 2011). The study involved data from National Centre for Child and Adolescent Psychiatry as well as criminal records from National Register of Criminality, with patients within the sample being re-diagnosed based on an ICD-10 screening criteria for ADHD. The results pointed conclusively to the belief that an individual diagnosed with ADHD but without conduct disorder, was not at a predictably greater risk to future delinquency, compared to the rest of the

study sample. A large proportion of the effect on delinquency likelihood was generated from conduct disorder. Results from a Canadian prospective study (Pingault, Côté et al. 2013) found consistent results to the above stance. The study was based on a population sample of youths from ages 6-12 years old that were assessed by parents and teachers with follow-up on criminal outcomes occurred at age 25 years. The study took into account conduct disorder/physical aggression as well as other control variables. The results found no strong associations between ADHD diagnosis in youths and future outcomes of adult crime. Instead, the strongest driving factors for future criminal activity were found to be physical aggression, as well as family adversity.

Recently, Behnken, Abraham et al. studied the relationship between ADHD and criminality for African American youths in Iowa. Consistent with Mordre, Groholt et al., the study found no direct correlations between ADHD and adult outcomes of crime. In spite of this, the results did point to indirect influences of ADHD on areas such as education, which in turn would potentially affect adult criminality outcomes. The study found that an ADHD diagnosis projected for unfavourable assessments by teachers in terms of students conduct. This would indirectly forecast ‘subsequent exclusionary school discipline’ which could therefore predict criminal outcomes in adults. In Iceland, a study was conducted aiming to ‘disentangle the relationship between offending, ADHD, and co-morbid risk factor’ (Gudjonsson, Sigurdsson et al. 2012). While the study found ADHD was a factor in 8.2% of nonviolent delinquency and 8.8% in violent delinquency. However, once conduct disorder and substance abuse were controlled for, these results were minimised. This suggested that ADHD diagnosis and criminality was predominantly due to the indirect effects of control factors. As with the other studies in this area, conduct disorder and ‘behavioural risk factors’ seem to be a greater predictor of crime compared to individuals diagnosed with ADHD. As mentioned in the findings for healthcare utilisation costs, D’Amico, Knapp et al. were found to have screened based on ‘high hyperactivity and conduct problem scores’ instead of typical ADHD screening criteria in this area. Due to this, there was no available information comparing their methodology to standard measures such as ICD-10 or DSM-IV. Nonetheless, a comparison of the societal expenditures between hyperactivity, conduct disorder and control groups was based on a 20-year follow-up study in the UK. It was found that criminal justice costs were lowest in the hyperactivity group, compared to the conduct disorder group (which had the highest amount of costs) and surprisingly, even lower than the control group.

### **3.8 Discussions of Criminality and ADHD**

Surprisingly, the general consensus from more recent papers investigating ADHD and criminal activity has been that diagnosis of ADHD has no clear consequences on criminality or on

recidivism. This is a stark contrast to the intuition of much earlier papers (Taylor, Chadwick et al. 1996, Young 2000) which have strongly associated ADHD to co-morbid issues of conduct disorder as well as criminal activity. The principle argument in this area is the fact that many recent papers - and certainly all the papers included - have been able to control for several other behavioural disorders, of which conduct disorder is the most important confounder that has been considered. The studies recently presented have all indicated conduct disorder to be a large motivator for criminality, rather than ADHD diagnosis by itself and when judging ADHD independently, the likelihood of a criminal conviction is no greater than controls without any behavioural disorders. While the results yielded cannot be aggregated into our total cost of illness projection - since costs are the same, if not lower than controls (D'Amico, Knapp et al. 2014) - it was nonetheless critical to include this aspect of society within our findings. Crime as both a source of financial burden and as a societal outcome is always an important consideration to society, and certainly when considering societal costs. Furthermore, the understanding that conduct disorder (and considering it independently from ADHD) is a larger catalyst of criminal offending than ADHD itself is a matter that should be raised to more attention to policymakers.

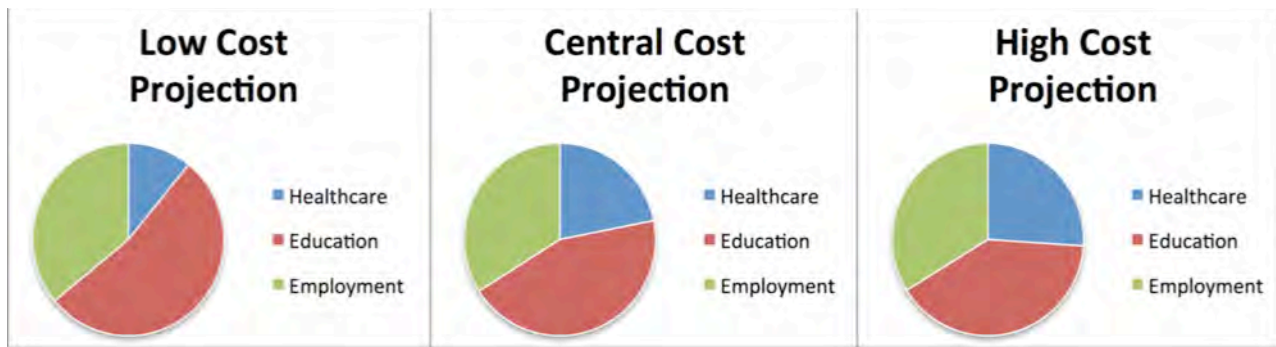
### 3.9 Total Cost of Illness Projection

Total cost of illness for ADHD has been derived from the healthcare, education and employment values derived from the various studies analysed within this dissertation. A full table of projected results has been presented in Table 1 and Figure 1. The total annual cost of illness projected for an individual born in 2013 has been estimated to be £102,135.89 over the course of 50 years with an annual discount rate of 2.5%. Apart from our central estimates, there has been consideration for Low (aggregating only the lowest values from each category) and High (aggregating only the highest values from each category) projected values. The highest projected value for overall cost of illness was projected to be £131,085.32 while the minimum projection was found to be £69,656.56. Looking at the breakdown categorically, education was found to have the smallest range of the three categories, as well as the largest burden of costs over the individual's lifetime for all estimations.

**Table 4**

	<b>Low (£)</b>	<b>Average (£)</b>	<b>High (£)</b>
<b>Healthcare</b>	7,542.76	22,315.46	34,187.34
<b>Education</b>	37,022.96	45,075.31	52,498.59
<b>Employment</b>	25,090.85	34,745.12	44,399.39
<b>Total Lifetime Cost</b>	69,656.56	102,135.89	131,085.32

Figure 1



### 3.10 Discussion for Cost of Illness

The extrapolation of our results and generation of the cost of illness have yielded high estimates for the projected societal costs of ADHD. Though this is an estimation of societal costs, it is apparent that a large burden of the costs falls on the responsibility of the public sector which gives reason for the government to research better interventions to reduce their long-term costs. While all three categories are expensive, education costs have been found to have the largest burden out of the main categories - a finding which is consistent with other studies considering societal costs of ADHD (Le, Hodgkins et al. 2013). Despite having the smallest timeframe, education costs carry a greater burden overall compared to healthcare utilisation and income losses. This result raises the consideration that interventions should be targeted at reducing education costs for individuals diagnosed with ADHD, not only for the direct benefits of lower costs, but also the potential effects from indirect associations with education discussed previously. However, one could make the case that this is due to the time period of healthcare and employment to be limited until an individual is 50 years old. There is a strong possibility that if we were to raise this threshold, healthcare utilisation might have a greater impact, though this in itself is unlikely due to the discount rate exponentially increasing and reducing future costs.

### 3.11 Study Limitations

From our analysis, it is clear that there is a significant burden of lifetime costs associated with an individual suffering from ADHD. While we have been able to project this estimate based on the available data in the literature, this raises the issue of potential underestimation in our determined value of the lifetime costs of ADHD, given the assumptions that we have made in our projections, as well as the structural restrictions due to the inherent limitations of the papers we have used. While we have tried to account for the four main categories associated with societal costs, it does raise the question of underestimation since indirect costs have not been included in our evaluation. Intangible costs and quality of life differences is a large area that was unaccounted for in the

analysis due to a lack of data available in the literature. Our focus on tangible costs stems from the availability (or lack thereof) of data and while costs related to “utilisation of accident and emergency services” would refine our results, we do not have the required information. Similar to issues found in Telford, Green et al., there was a lack of available data on broader issues from a societal perspective “such as unemployment in older adolescents and lost working days by parents”. One of the biggest limitations raised in the discussion is the discrepancy of ADHD screening methodologies between results. From the available literature, there are two methodologies that are used predominantly in the healthcare sector to diagnose ADHD: DSM-IV and ICD-10. However, while they are both meant to measure the same disorder, there is a large difference in the severity of diagnosis that is accounted for in the methodologies, with ICD-10 picking up more severe (and therefore, more costly and potentially longer lasting) symptoms, whereas DSM-IV accounts for milder diagnoses.

Co-morbidities are always an issue, especially within a topic dealing with mental health disorders. Not all of the available studies were able to control for confounders, especially conduct disorder (which is generally associated with ADHD). Costs associated with disruptive behaviour attributed to ADHD may perhaps be due to other confounding factors that have not been accounted for. Another consideration in our results was the inability to fully compare results by gender since there is concern that lower prevalence rates for females is an indication of the “neglect of the problems experienced by girls with ADHD (Berry, Shaywitz et al. 1985) and more importantly, that this is plausible evidence for the “associated difficulties and the source of treatment for different types of childhood problems” (Gaub and Carlson 1997). Since male patterns of ADHD often cause a display of “more disruptive behaviours within structured settings, leading to higher referral rates”. Conversely, given that females with ADHD have more subtle tendencies, there is a likelihood that the effect and cost treatments for females may be understated since there is a lack of referral towards “clinic-based treatment” and additionally, overall costs may be significantly higher when accounting for gender differences in the analysis.

One of the bigger limitations in our review (of healthcare and education costs) was determining the consistency of what papers were factoring into the costs of their analyses. From our review, it was apparent that there was a lack of consistency or ‘standard approach’ to factoring costs within individual papers. This raises the matter of inconsistency when attempting to compare results which is reflected in the variance of costs that we have examined. Finally, a large issue when considering the annual average costs on education and healthcare is how the proportion of utilisation and costs are distributed amongst the diagnosed population. From our results, it is obvious that a large



proportion of the cost burden generated for education and healthcare is utilised by a small percentage of the population, which raises the issue of underestimation in our projected results.

Despite these limitations and assumptions, the driving factor of this analysis was to present a quantified representation of the costs of ADHD from a lifetime perspective. Despite being relative estimation of the associated costs, it is nonetheless representative of the potential costs one may expect when being diagnosed for ADHD and in turn, what can be done in terms of early interventions to prevent these future costs from developing.

## **4 RECOMMENDATIONS FOR FUTURE RESEARCH**

Given our findings, the undeniable suggestion for policy based on the results is a need for more systematic identification linked to better and earlier interventions for individuals with ADHD. Our total cost of illness projections for the lifetime of an individual have highlighted a huge generation of costs, which could be potentially avoided through better interventions preventing these issues from arising in the first place. Moreover, these cost estimates have not captured the intangible, quality of life values that are associated with such an illness, raising the notion that these estimates are still undervalued.

The categorical analysis in this dissertation suggests that fewer resources should be expended on the prevention of juvenile delinquency in ADHD cases since there is little evidence to indicate a direct association between the two. Additionally, more focus should be implemented on education outcomes, given it is not only a large burden on society during an individual's youth/adolescent stages, but there are added concerns over indirect effects of education on future employment and income outcome. Another surprise was the lack of quantified evidence on income losses and employment outcomes in the UK due to ADHD. Given our understanding of the significant differences internationally in this area, it is imperative that a British study be undertaken to find a relative estimate for research purposes.

There is plenty of room for future research when discussing ADHD. More work should be pursued to disentangle the effects of conduct disorder and ADHD. Furthermore, greater consideration should be undertaken to identify and quantify the indirect effects of a mental disorder such as ADHD. In terms of research policy, an ideal proposition would be the inception of a standard procedure when analysing the methodological breakdown of costs. From a broad standpoint, an important recommendation would be stressing the importance of early identification of ADHD. As mentioned

above, the variation between DSM-IV and ICD-10 diagnosis creates an inaccurate amount of uncertainty when attempting to compare and contrast results of different specifications, causing inconsistency in prevalence rates and cost figures in general.

Additionally, standard measures and guidelines for calculating total healthcare and education costs should be considered. While standardisation may sacrifice the omission of certain costs, we gain the ability to accurately compare results on both national and international scales, while also allowing us to compare different systems. Based on the results of our analysis, the ability to analyse based on relative consistency is an issue that should be taken into consideration to give us robust results, which is imperative from both an academic and social policy perspective.

## **5 CONCLUSIONS**

This dissertation has shown that ADHD is a costly problem to society from both an annual and lifetime perspective. In particular, we have evaluated the individual responsibilities of the four main areas of society (education, healthcare, employment and crime) as well as projecting the total cost of illness over the lifetime of an individual. Given the analysis, there is a firm belief that a reduction of these costs through better interventions would yield strong financial benefits in the long run. While most studies have customarily considered costs from an annual perspective, this dissertation has also extrapolated the lifetime costs, which is necessary when evaluating such a disorder - there is importance in considering the cost trajectories of the individuals and the overall burden of cost would not be apparent if compared to a traditional, annual perspective. Our results place a need on the emphasis for better and earlier interventions for youths diagnosed with ADHD and specifically, better-targeted use of education resources and costs. This dissertation has also highlighted the need for better and more consistent information to derive better policy decisions and research analysis in the field of ADHD.

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# APPENDIX

## A1 Summary of Evaluated Studies

Study	Country	Prevalence Rate	Methodology & Sample Size	ADHD/Hyperkinetic Screening Criteria	Ages	Summary of Findings	Categorical Costs
Behnken, M. P., Abraham, W. T., Cutrona, C. E., Russell, D. W., Simons, R. L., & Gibbons, F. X. (2014)	USA	Ages 4-17 years old: 9.5% (Centers for Disease Control and Prevention, 2010).	Path model analysis on a sample survey of African American individuals (n = 211) taken from Des Moines, Iowa, USA from a subsample of the Family and Community Health Study.	DISC-IV (Shaffer et al., 1993). The DISC-IV remains consistent with DSM-IV for ADHD testing. Dependability and consistent of the DISC-IV is considered in Shaffer et al., 1993.	Initial ages: 10-12 years. Follow-up at 12-18 years & 18-23 years.	No direct influence of ADHD on criminality outcomes as an adult. Some indirect effects found (negative teacher ratings of behaviour), leading to issues such as exclusionary school discipline/juvenile arrests correlating to future crime.	Crime
Biederman, J., & Faraone, S. V. (2006)	USA	American prevalence rate (adults) 5% in the US population - Derived from Kessler RC, Adler L, Barkley R, et al. (2006) & Faraone SV, Biederman J. (2005).	Econometric analysis based on two groups of patients - ADHD (n=500) and controls (n=501) - derived from telephone surveys in 2003.	Telephoned interviewees were asked if they had been diagnosed with ADHD or not. No information given regarding consistency with DSM-IV or ICD-10 measurements.	18-64 years.	Comparison of employment rates between ADHD and control groups found ADHD sufferers to be lower (33.9%) compared to control (59.0%). Difference in income between study groups: \$10,300.	Employment
Birchwood, J., & Daley, D. (2012)	UK	Derived sample prevalence: 11.7%	Regression analysis based on survey of individuals (n=324) (year 11 pupils) from four state schools in the West Midlands, and North Wales, UK.	Screening criteria based on Adult ADHD Rating Scale (AARS) (Barkley & Murphy, 1998). AARS is a self-reported measurement consistent the DSM-IV.	15-16 years.	ADHD was found to be a strong predictor of academic performance, and considered to be as important as motivation and cognitive ability. Adolescents were more susceptible to academic difficulties if suffering from ADHD.	Education
D'Amico, F., Knapp, M., Beecham, J., Sandberg, S., Taylor, E., & Sayal, K. (2014)	UK	-	Longitudinal analysis and extrapolation of predicted costs based on unit costs from NHS reference costs for 2009/10 and PSSRU 2010. Sample drawn from 6- to 7-year-old male youths from the London Borough of Newham from mainstream schools (n=83) in 1981-1983. Follow-up occurred between 2001-2003.	Based on Parent-rated Rutter A(2) and Teacher-rated Rutter B(2) questionnaires. Measured symptom severity instead of screening disorder. No informatio about consistency with DSM-IV or ICD-10.	Initial ages: 6-7 years. 20 year follow-up	Conduct disorder correlates strongest to criminal justice costs compared to ADHD and controls. Healthcare/societal costs were consistent amongst study groups. Childhood predictor values were uncorrelated with employment status.	Crime Healthcare
Gjervan, B., Torgersen, T., Rasmussen, K., & Nordahl, H. M. (2012)	Norway	The average prevalence of adult ADHD in the general population has been estimated to be 3.4% in a large cross-national study (Fayyad et al., 2007).	Study sample derived from Patient Administrative System at Levanger and Namsos hospitals, Department of Psychiatry, Norway with individuals diagnosed ADHD (n=149). Multiple regression analysis applied in study.	ADHD diagnos based on ICD-10 criteria and additionally, a confirmed diagnosis based on an experienced psychiatrist.	18+ years	ADHD individuals reported 22.2% employment compared to general population rate of 72%. Lifetime depression (37.8%), substance abuse (28.1%), and alcohol abuse (23.3%) were found to be strong comorbid factors.	Employment

Grieger, L., & Hosser, D. (2012)	Germany	Prevalence of ADHD in adulthood: 2.7% (Lara et al., 2009). Cross-national prevalence rate of adult ADHD: 3.4% (Fayyad et al., 2007).	Regression analysis based on survey data from three separate prison facilities for juvenile delinquents. Individuals (n=283) were examined for ADHD through either the FEA-FSB and FEA-ASB (Döpfner, Steinhausen, & Lehmkuhl, 2002).	The FEA-FSB/FEA-ASB are retrospective measurements for ADHD symptoms in youth and adulthood. Both are consistent with DSM-IV screening criteria. While there were questions related to ICD-10, they were omitted.	15-24 years	A large proportion of prisoners were found to have suffered from childhood ADHD. However, prisoners diagnosed with ADHD were not significantly more likely to reoffend according to $\chi^2$ tests.	Crime
Gudjonsson, G. H., Sigurdsson, J. F., Sigfusdottir, I. D., & Young, S. (2012)	Iceland	Worldwide prevalence rate: 5.3% (from Polanczyk, de Lima, Horta, Biederman, & Rohde, 2007)	Multiple regression analysis on sample of Icelandic high-school students (n=11,388) in 2010.	ADHD criteria used: Barkley Current Symptoms Scale (Barkley, 1998). Methodology remains consistent with DSM-IV.	16-24 years	Study found that association between ADHD and criminality of adolescents was largely attributed indirectly to comorbidity of factors.	Crime
Hakkaart-van Roijen, L., Zwirs, B. W. C., Bouwmans, C., Tan, S. S., Schulpen, T. W. J., Vlasveld, L., & Buitelaar, J. K. (2007)	Netherlands	5-14 year olds (All): ~8% Prevalence rate taken from Faraone SV (2003)	Survey of parents and relevant cost data derived from Trimbos and iMTA questionnaire on Costs associated with Psychiatric illness' (TiC-P). Case group (n=70) identified as youths suffering from ADHD that were being treated by a pediatrician.	Diagnosis screening based on the DSM-IV method. Additionally, a select group of children in the ADEON study (n=60) were considered for comparison of behaviour problems. Also based on DSM-IV criteria.	Average age: 10.5 years	High healthcare costs from ADHD patients. Mothers of ADHD children were found to have higher mental healthcare costs. Indirect costs such as absence from work, reduced efficiency and job performance were correlated to having ADHD children.	Employment (Mothers) Healthcare
Halmøy, A., Fasmer, O. B., Gillberg, C., & Haavik, J. (2009)	Norway	Adult prevalence rate of ADHD in cross-sectional studies: 2% ~ 4% (Fayyad et al., 2007; Kessler et al., 2006).	Logistic regression on sample derived from National registry of adult ADHD in Norway who fit study criteria (n=414) (Halleland, Lundervold, Halmøy, Johansson, & Haavik, 2008; Johansson et al., 2008).	ADHD diagnosis based on ICD-10. However, two modification were made to allow for the inattentive subtypes based on DSM-IV to allow for presence of comorbid psychiatric disorder.	18+ years	Individuals with ADHD reported 24% employment rate, compared to 79% in the control group.	Employment
Holden, S. E., Jenkins-Jones, S., Poole, C. D., Morgan, C. L., Coghill, D., & Currie, C. J. (2009)	UK	British 5-15 year olds (Boys): 3.62 % British 5-15 year olds (Girls): 0.85 %	Retrospective, observational cohort study based on observed cost data and existing studies. Data derived from the Clinical Practice Research Datalink (CPRD) between 1998 and 2010 for Cases(n=3229) and randomised Controls (n=7,429) that had no ADHD diagnosis.	Selection based on clinical history of ADHD or is they were prescribed/diagnosed for ADHD. No information on DSM-IV or ICD-10.	> 6 years	Prevalence and incidence rate derived from the study was found to be significantly lower compared to typical results in the UK. Costs for ADHD sufferers was found to be significantly (~300%) higher compared to controls.	Healthcare
Klein, R. G., Mannuzza, S., Olazagasti, M. A. R., Roizen, E., Hutchison, J. A., Lashua, E. C., & Castellanos, F. X. (2012)	USA	Worldwide prevalence rate: 5.3% (from Polanczyk, de Lima, Horta, Biederman, & Rohde, 2007)	Statistical analysis on based on a sample study (n=135) of Caucasian males with ADHD in childhood (but free from conduct disorder), with 33 year follow-up.	ADHD screening criteria based on DSM-IV methodology.	Initial ages: 6-12 years. Follow-up period: 30 years	Individuals with diagnosed ADHD had 2.5 years less schooling compared to controls. As well as lower rates of high school graduation. ADHD sufferers had lower employment rates (83.7%) compared to controls (94.9%). Difference in annual earnings found to be \$40, 000.	Education Employment



Mordre, M., Groholt, B., Kjelsberg, E., Sandstad, B., & Myhre, A. M (2011)	Norway	-	Univariate and multivariate Cox regression analyses. Utilised survey and follow-up data of a Norwegian cohort of youth psychiatric in-patients (n=541).	ADHD screening based on ICD-10.	Initial age: 13 years of younger Follow-up period: 19-41 years	Youth ADHD lacked correlation with delinquency compared to other disorders. Conduct disorder found to be correlated with future criminality. Lack of direct association with ADHD and criminality.	Crime
Pingault, J. B., Côté, S. M., Lacourse, E., Galéra, C., Vitaro, F., & Tremblay, R. E. (2013)	Canada	-	Survival analysis (and complementary analysis) on criminal activity at age 25 applied to a population-based sample of kindergarten children (n=2,741) in Quebec between 1986-1988	Based on SBQ- derived from the Children's Behavior Questionnaire and the Preschool Behavior Questionnaire. No information about consistency with DSM-IV or ICD-10.	6-12 years. Follow-up at 25 years.	Study found physical aggression and family adversity to be greater predictors of future criminality of individuals compared to ADHD.	Crime
Robb, J. A., Sibley, M. H., Pelham Jr, W. E., Foster, E. M., Molina, B. S., Gnagy, E. M., & Kuriyan, A. B (2011)	USA	American prevalence rate: ~10% of children and adolescents (CDC, 2005)	Report based on Pittsburgh ADHD Longitudinal Study with annual economic values extrapolated from incurred costs based on special education allocations and grade retention.	ADHD screening criteria based on DSM-III-R or DSM-IV.	Initial: 5-17 years. Follow-up: 11-28 years.	Students with ADHD utilized more education services compared to those controls and hence, incurred a higher annual cost to the US Education system. Recommendations were aimed at prevention and intervention methods to reduce the financial burden due to ADHD.	Education
Snell, T., Knapp, M., Healey, A., Guglani, S., Evans-Lacko, S., Fernandez, J. L., ... & Ford, T. (2007)	UK	5-15 year olds (Boys): 2.4 % 5-15 year olds (Girls): 0.4 % 5-15 year olds (All): 1.4% Gatward, R., Goodman, R., & Ford, T. (2000)	Retrospective, observational cohort study based on observed cost data and application of existing studies. Based on the Development and Well-being Assessment (DAWBA) (n=445).	Questions in the DAWBA are directly associated to the demands of both the ICD-10 and DSM-IV diagnostic specifications. Clinicians imputed data to diagnose ADHD using the ICD-10 criteria.	5-15 years	~ 10% of British children suffer from hyperkinetic disorder, emotional disorder or conduct disorder. ADHD found to have highest total mean cost compared to other disorders. The bulk of the cost is derived from the education sector.	Education Healthcare Social Care
Telford, C., Green, C., Logan, S., Langley, K., Thapar, A., & Ford, T. (2010)	UK	British 5-15 year olds (Boys): 3.62 % British 5-15 year olds (Girls): 0.85 % Worldwide prevalence rate: 5.3% (from Polanczyk, de Lima, Horta, Biederman, & Rohde, 2007)	Longitudinal study. Perspective of third party payers (National Health Service (NHS), Personal Social Services (PSS) and Department for Education) for the youths over the course of one year. Used the Cardiff Longitudinal ADHD Study (CLASS) study (n=157). Final sample size was n=143.	Individuals were screened for ADHD/hyperkinetic disorder through either DSM-IV or ICD-10 screening methods. Additionally, individuals had to meet the criteria of being aged 12-18 years old at the 5-year follow-up.	12-18 years	In spite of the early treatments in childhood for ADHD, the study suggests large costs due to the mental disorder, consistent with other American results. Education is a large proportion of these costs, along with health services.	Education Healthcare

## A2 Healthcare Cost Data Summary

Study	Country	Year of Costs	Healthcare Costs (Local Currency)	Healthcare Costs in GBP (£)	Estimated Total Cost in GBP for 2012/2013 <sup>6</sup>
Telford, C., Green, C., Logan, S., Langley, K., Thapar, A., & Ford, T.	UK	2010	1310.02	1,310.02	1,410.00
Holden, S. E., Jenkins-Jones, S., Poole, C. D., Morgan, C. L., Coghill, D., & Currie, C. J.	UK	2009	811.25	1,146.00	1,240.86
Snell, T., Knapp, M., Healey, A., Guglani, S., Evans Lacko, S., Fernandez, J. L., ... & Ford, T.	UK	2007	268.80	268.80	311.09
D'Amico, F., Knapp, M., Beecham, J., Sandberg, S., Taylor, E., & Sayal, K.	UK	2010	536.00	536	576.91
Hakkaart-van Roijen, L., Zwirs, B. W. C., Bouwmans, C., Tan, S. S., Schulpen, T. W. J., Vlasveld, L., & Buitelaar, J. K.	Netherlands	2004	1173.00	826.55	1,062.97
<b>Average Total Cost Estimated in GBP for 2012/2013</b>					920.37

<sup>6</sup> Green highlights are values used for High estimations while Red highlights are values used for Low estimations.

### A3 Education Costs Data Summary

Study	Country	Year of Study	Education Costs for ADHD (Local Currency)	Education Costs for ADHD in GBP (£)	Estimated Total Cost in GBP for 2012/2013 <sup>7</sup>
Telford, C., Green, C., Logan, S., Langley, K., Thapar, A., & Ford, T.	UK	2010	4,155.03	4,155.03	4,472.15
Snell, T., Knapp, M., Healey, A., Guglani, S., Evans Lacko, S., Fernandez, J. L., ... & Ford, T.	UK	2007	2,725.11	2,725.11	3,153.84
Robb, J. A., Sibley, M. H., Pelham Jr, W. E., Foster, E. M., Molina, B. S., Gnagy, E. M., & Kuriyan, A. B	USA	2010	5,007	3,617	3,893.38
<b>Average Total Cost Estimated in GBP for 2012/2013</b>					3,839.79

<sup>7</sup> Green highlights are values used for High estimations while Red highlights are values used for Low estimations.

## A4 Employment Losses

Study	Country	Year of Study	Employment Rate of ADHD (%)	Employment Rate of Control (%)	Employment Rate Difference (%)	Average Loss in Employment for Local Currency in year of Study)	Average Loss in Employment for GBP (£) (In year of Study)	Estimated Total Difference in GBP for 2012/2013	Expected Loss of Income in GBP (£) <sup>8</sup>
Halmøy, A., Fasmer, O. B., Gillberg, C., & Haavik, J.	Norway	2009	24.0%	79.0%	55.0%	-	-	-	
Gjervan, B., Torgersen, T., Rasmussen, K., & Nordahl, H. M.	Norway	2012	22.2%	79.0%	57%	-	-	-	
Klein, R. G., Mannuzza, S., Olazagasti, M. A. R., Roizen, E., Hutchison, J. A., Lashua, E. C., & Castellanos, F. X.	USA	2012	83.7%	94.9%	11%	40,000.00	29,547.97	30,238.29	3,386.69
Biederman, J., & Faraone, S. V.	USA	2006	33.9%	59.0%	25.1%	10,300.00	6,353.73	7,625.00	1,913.88
							<b>Expected Income Loss Estimated in GBP for 2012/2013</b>		2,650.28

<sup>8</sup> Green highlights are values used for High estimations while Red highlights are values used for Low estimations.