Measuring, valuing and including forgone childhood education and leisure time costs in economic evaluation: methods, challenges and the way forward.

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Abstract

Economic evaluations carried out to inform the allocation of finite public funds ought to take into account all relevant costs and benefits. When such evaluations adopt a societal perspective, it is important that they include 'time-related' costs arising from productivity and leisure time losses due to receipt of care, ill health or both. For programmes that relate to children, similar costs arise from forgone time, though there is a distinct lack of insights into how such costs should be identified, measured and valued. We set out to explore how forgone time—including absence from formal education and childhood leisure time—can be estimated and incorporated into economic evaluations. To do so, we look at theories and approaches to time valuation proposed in different disciplines and we discuss their suitability for use in health economics research. We find that, while there is a sizeable literature on time valuation methods in education, labour and transportation economics, much of this is not directly applicable to economic evaluation of health care interventions for children. We identify gaps in existing methods and practice, we outline challenges in moving forwards and we provide a list of considerations aiming to assist researchers in deciding whether, and how, to include foregone time-related costs in economic evaluation.

Research Highlights

- Time is an input that should be valued and accounted for in economic evaluations.
- Little guidance on how to value time loss in children within the economic literature.
- Existing approaches to time valuation in adults are hardly applicable to children.
- Numerous and persistent challenges in measuring and valuing time loss in children.
- Analysts to consider when inclusion is essential and how losses can be best expressed.

Keywords

Monetary value of time; time valuation; children; economic evaluation; returns to education; opportunity cost of leisure time.

1. Introduction

The last five decades have seen an increasing use of economic evaluations as a means of determining the desirability of various courses of action competing for public funds. Such analyses have found application in different sectors, including transportation (Mackie, 2005), education (Levin, McEwan, Belfield, Bowden, & Shand, 2017) and, perhaps most prominently, health care (Drummond, Sculpher, Torrance, O'Brien, & Stoddart, 2005; Weinstein, 1981). In this field, economic evaluations—typically in the form of cost-effectiveness and cost-utility analyses—are routinely undertaken to inform funding decisions about interventions, programmes or policies, many of which relate to children (Currie, 2009).

Undertaking an economic evaluation in health care involves identifying and comparing the use of resources (inputs) and benefits (outputs) of alternative activities considered for reimbursement or funding. Inputs should be valued in a way that reflects their opportunity cost, and outputs should aim to capture impact on one's health or wellbeing. The exact categories of inputs to be included depends on the perspective of the evaluation. A societal perspective is often advocated as the most appropriate viewpoint for capturing and reflecting the breadth of costs and benefits that is necessary for guiding optimal societal decision making (Drummond et al., 2005; Jöhnson, 2009; Neumann, Sanders, Russell, Siegel, & Ganiats, 2016). When the evaluation is carried out from such a perspective, it is important that all salient resources and their opportunity cost are taken into account, including those borne by the health care system, other sectors of the economy, the patient and their informal carers, and society as a whole.

Time is such a resource: it is limited, it is an input in the production of other goods, including health, and its use entails an opportunity cost (Becker, 1965; Grossman, 1972). If, for example, the process of receiving care results in forgoing time which would have been spent on other activities, then the opportunity cost of this time needs to be measured, valued and included in economic evaluations (Dranove, 1996). To determine the magnitude of this opportunity cost, one has to estimate the value of activities that may have been displaced by time spent receiving care.

Similarly to research in other fields of economics, much of the available literature on the value of time has concentrated on working-age adults, whose time is typically thought to be allocated across two key activities: work (paid or unpaid) and leisure (Gronau, 1977; Jara-Díaz & Rosales-Salas, 2017). Indeed, there is now a maturing body of useful literature on methods for measuring and valuing 'time-related' losses in this group. However, the greatest share of this literature focuses on loss of productive time due to absence from paid or unpaid work (Krol & Brouwer, 2014; Zhang, Bansback, & Anis, 2011), with losses due to forgone leisure time receiving less attention (Sendi, Al, Gafni, & Birch, 2004; Tranmer, Guerriere, Ungar, & Coyte, 2005). Equally, the bulk of this literature is not directly applicable to economic evaluations of interventions aimed at children. The fact that children are legally protected against participating in paid labour and are required to attend full-time education

means that valuing children's forgone time by drawing on the available literature on adults is bound to be unsatisfactory.

With this in mind, we set out to discuss how children's forgone time—including absence from formal education and leisure time—can be measured and valued so that it can be used in economic evaluations of health interventions. We look at economic evaluations in general, rather than at a particular type of such studies, and we consider the opportunity cost of forgone time in monetary terms (as part of the 'numerator' of an economic evaluation). While it is possible to express forgone time in terms of its impact on patients' quality of life (i.e. as part of the 'denominator') (Brouwer, Koopmanschap, & Rutten, 1998), such an approach is not without limitations, including the fact that its relevance is pragmatically restricted to types of evaluations where outcomes are expressed in terms of quality of life (Sendi & Brouwer, 2004).

The remainder of the paper is structured as follows. In the next section, we describe the methods we used to identify the methodological and applied literature that we draw upon and discuss throughout this paper. This is followed by a discussion of the rationale for the inclusion of 'time-related' opportunity costs in economic evaluations, and a brief section on broad groups of activities that children's time typically falls within. We then look at approaches and aspects related to measuring and valuing forgone education and leisure time, and we discuss the theoretical basis and empirical evidence underpinning them. We offer a list of relevant considerations that, we suggest, analyst and decision makers should bear in mind and consider when endeavouring to incorporate (or take into account) time-related costs in economic evaluations. We close by outlining important methodological and practical challenges in moving forward.

2. Methods

We planned and carried out two separate but interrelated literature reviews. The first aimed to identify whether, and how, 'time-related' opportunity costs have been used in applied economic evaluations of technologies, programmes and interventions targeting children. To do so, we searched the Paediatric Economic Database Evaluation (PEDE), a bibliographic database that contains detailed information on over 3000 full economic evaluations published in the last 30 years. We used the database's interface to carry out searches in April 2018 using search terms related to school absence and leisure time valuation. As this database is updated annually, searches in PEDE yielded full economic evaluations published between January, 1st 1980 and 31st December 2016.

The second review involved searches to identify information, ideas, approaches and 'schools of thought' related to valuing the opportunity cost of children's time, within and beyond health care. We searched major electronic bibliographic databases (EconLit, Education Research Complete, PubMed, SCOPUS and the Web of Science) by combining key words, synonyms, term variants and expressions related to the following key concepts: opportunity cost, monetary valuation, leisure time and absence from formal education. Searches were designed with a focus on sensitivity and were intentionally

broad in order to maximise the yield of potentially useful articles (see Electronic Supplementary Material). Furthermore, we contacted experts in relevant areas and used various citation searching techniques. These included 'related-article' searches in PubMed and 'citation pearl growing', which involved scanning references that cite, and are cited by, identified key articles using built-in features in SCOPUS and Web of Science.

3. Rationale for the inclusion of 'time-related' costs in economic evaluation

The need to identify methods that accurately capture the value of time is by no means unique to economic evaluations of health care technologies. Analysis of time and its allocation has been a well-researched topic in the broader economics literature, with much of the interest focusing on welfare changes resulting from individuals' or households' decisions to commit their finite time to different activities. Literature that is widely considered to have laid the foundations of this topic typically draws a broad distinction between two key activities: work (paid or unpaid) and leisure (Becker, 1965; DeSerpa, 1971; Mincer, 1962). Becker's (Becker, 1965) seminal work on time allocation was subsequently taken forward in different fields of enquiry and was refined and used for different purposes. In labour economics, for example, the study of time and its value has largely served the purpose of understanding how the allocation of individuals' time between work and non-work activities affects the labour market (Blundell, Chiappori, Magnac, & Meghir, 2007; Heckman, 1976). In the economics of transportation, research often focuses on the value of time spent travelling, with a view to understanding commuters' choices or identifying whether the monetary benefits of funding and completing infrastructure projects—such as motorways and high speed rail connections—exceed the cost of such investment (Jara-Díaz & Rosales-Salas, 2017; Munshi, 1993).

In economic evaluation of health care interventions, recognising that individuals' time is finite and valuable makes it clear that the opportunity cost of this time should be quantified and incorporated into cost calculations (Dranove, 1996; Drummond et al., 2005; Posnett & Jan, 1996). While translating loss of time into opportunity cost is complex, not doing so risks penalising interventions, programmes or treatments that may be less time-consuming—and, by extension, impose lower costs—to patients. This can be easily seen through using an example akin to that used by Drummond et al. (Drummond et al., 2005) to explicate the need for valuing time forgone from paid employment. To begin with, imagine that a new treatment is considered for use in patients suffering from a hypothetical condition. Further, imagine that the only difference between the new treatment and current practice is that the new treatment can be delivered through fewer visits to health care facilities (e.g. two, rather than five hour-long appointments) and therefore takes up less of a recipient's time. In this case, it is obvious that moving to the new programme would result in a welfare change, which would be inevitably missed out were savings in time (and their corresponding monetary value) not taken into account.

Whether this change would result in an overall welfare increase or decrease depends partly on the value attached to an additional unit of time. Clearly, to obtain an accurate estimate of this value, one

needs to consider what activities would be forgone due to the additional visits and who bears the consequences of this loss, keeping in mind that the interest should be on consequences that lead to net changes in welfare (as opposed to transfers which merely redistribute income). If receiving care displaces a patient's (and/or their family's or unpaid carers') leisure time, the relevant opportunit cost should reflect the loss of utility due to not being able to engage in leisure activities. On the other hand, if the displaced time is time taken off paid employment and the individual is compensated for this, the relevant opportunity cost will be due to reduced productivity, which in turn represents a cost to society.

To a certain extent, one might assume that the principles of estimating the opportunity cost of lost time may hold true irrespective of whether the individuals to whom time losses are incurred are young children, adolescents or adults. However, there are notable differences between the activities that adults and children may forgo, which makes it necessary to use different assumptions and different methods of valuation. The way in which children divide their time has an effect on the ways that 'time-related' losses can be valued for this group of individuals and is discussed below.

3.1 Division of time in childhood

A first key consideration in exploring the cost of time relates to how this time would have been spent, should it have not been foregone due to receipt of health care and/or ill health. In models related to working-age adults, a distinction is typically made between i) time spent carrying out paid or unpaid work (e.g. childcare, adult care, volunteering, housekeeping etc.) and ii) leisure time. The latter is defined here as all those activities that one cannot pay somebody else to do and does not have to do at all if they do not wish to (Burda, Hamermesh, & Weil, 2007) (including, for example, engaging in sports, hobbies, cultural activities, computing; spending time on mass and social media, eating out and spending time to travel to pursue leisure activities). Depending on which category lost time falls within, different assumptions and approaches are used to value lost time (Krol & Brouwer, 2015; Posnett & Jan, 1996; Sendi & Brouwer, 2004).

However, the division of time in school-age children is markedly different to that of adults. For example, in most countries, international conventions and legislation prohibits or restricts child labour until a specified age is reached. Instead of engaging in paid employment, children are required to attend full-time education, thus a considerable amount of children's time is taken up by schooling. Time diaries completed by children and their parents point to a broad categorisation of time into the following activities: i) time spent on activities related to formal education (including time spent travelling to school, time at school and time spent on school-related preparatory work), ii) time spent on necessary activities, such as eating and sleeping, and iii) time spent on leisure activities (including play time, and time spent on sports, entertainment and media) (Mullan, 2014). The allocation of time to these types of activities tends to vary across age groups and days of the week (weekend or week days). As school-age children have to attend school, it is sensible for the economic analyst to treat

children's school time as 'contracted' or 'non-discretionary' time (Robinson & Godbey, 2010). However, the boundaries surrounding children's leisure time are less clear. A simple, pragmatic approach applied to school-age children involves assuming that leisure time encompasses all uses of time except that spent in school or, by extension, travelling to school, time at school and time spent on homework. While some (older) children may spend some of their time on 'committed' activities (e.g. household, child or pet care obligations), which are by definition neither leisure activities nor paid work, for simplicity this paper assumes that children's time can be broadly divided into education and leisure. It is important to note that, throughout the paper, the term leisure is used to simply delineate and categorise the time spent on different types of 'discretionary' activities, which are, nonetheless, equally important and vital to a child's cognitive, emotional, social and physical development and growth.

3.2 Measurement of forgone time in children

A key step towards including the cost of children's time losses in economic evaluation involves collecting relevant data on forgone leisure or education time. Searches in PEDE identified a small number of studies that attempted to collect such data. Relevant characteristics of these studies are given in Table 1 below. Within this literature, no studies were identified that collected data on lost leisure time as a result of the delivery of health care. The identified literature focused exclusively on education losses and these were predominantly expressed as time spent away from school during illness episode(s) or as a result of school drop-out. This narrow pool of studies directly identified numbers of missed school days through various approaches, including: (i) monthly telephone interviews with caregivers or parents if children were under the age of 12 (generally attending preschool or primary school); (ii) face-to-face interviews at health facilities during follow-up appointments; (iii) diaries (completed by caregivers); (iv) surveys completed by children themselves (generally those entering or already in secondary school) and; (v) tracking of school administrative data. Collected data were expressed in terms of school days missed, with only one study measuring time lost from formal education in years. As expected, the frequency of data collection varied from weekly to annually depending on the interventions assessed or health conditions of interest, with asthma being the most commonly investigated ailment.

| Please insert Table 1 |

There are a number of methodological issues that apply to all studies that purport to measure time foregone by children as a consequence of receiving care or participating in a health intervention. Firstly, identifying the appropriate respondent should typically involve an assessment of the cognitive requirements of the measurement task with young children in particular unlikely to be able to complete cognitively challenging tasks. Secondly, perhaps contrary to expectations, data on children's time use reported by parents suffer from imprecision, with evidence suggesting that, in many studies, parent-reported times are quite inaccurate (Juster & Stafford, 1985). Thirdly, it is often difficult for

the respondent to distinguish between primary activities in which the child is heavily involved and secondary activities that may be happening at the same time and may be considered of lesser importance (Chatzitheochari et al., 2015). For example, such ambiguity may arise in situations where a child is watching a television programme (leisure) which may have an educational element. In addition, there is a range of extracurricular school activities, for example school-related sporting activities, where the distinction between education and leisure is quite opaque. Fourthly, reports on children's time use may be influenced by the season of the year or even the number of daylight hours (R. Larson, 1989). One response to this is to space the data collection across periods of the year, but this will have to be counterbalanced by the requirements for economic evaluation where, for example, a prospective study may require complete data over a defined follow-up period. Fifthly, when considering the frequency of data collection, the potential for recall biases will have to be balanced against completeness of sampling information and particular attention will need to be paid to the potential for accentuated recall biases in young children (Rebok et al., 2001). In addition, bar school administrative databases, there are very limited externally collected data that can be used to check the reliability of self-reported or parent-reported values for childhood activities. These challenges need to be borne in mind when designing a data collection exercise as part of an economic evaluation related to children and are revisited and discussed further in the Discussion section.

3.3 Valuation of lost leisure time in children

Determining the value of leisure time requires an understanding of what activities do, and do not, constitute leisure. However, defining leisure in a strict, prescriptive way is difficult as the concept and the activities it entails differ across individuals, for example children and adults. A widely cited definition of leisure has been given by Burda and colleagues (Burda et al., 2007)); the authors see leisure as a concept that *"encompasses those activities that the individual cannot pay other individuals to perform without losing their intrinsic value and that can be suppressed if needed, such as entertainment"*. Broadly, leisure has also been seen as "discretionary time", that is, time on activities over and above 'necessary activities' (Goodin, Rice, Bittman, & Saunders, 2005). An operational definition of leisure can be obtained by using the third-party rule proposed by Reid (Reid, 1934). According to the author, if an activity can be delegated to a paid worker, then that activity could be deemed 'productive'. Thus, one can define leisure as all those activities that we cannot pay someone else to carry out for us and that we do not have to carry out unless we wish to do so.

The theoretical basis for the analysis of time is thought to have been laid by Becker (Becker, 1965) and DeSerpa (DeSerpa, 1971), who attempted to incorporate time as a key element in consumer theory. This work introduced 'consumption time' as an input in the production of 'final goods', which are the basic source of utility, and explained that the trade-off between work and other uses of time (e.g. leisure) results in the marginal cost of leisure being equal to the prevailing wage rate. The key principles found in Becker's work (Becker, 1965) were taken forward by Heckman (Heckman, 1974,

1976) in an attempt to explain the impact of individuals' choices between work and leisure on the labour market. Assuming that individuals choose to spend time on work or leisure, their labour supply curve can be seen as the mirror image of their demand for leisure. For example, within a given length of time d (e.g. 24 hours), an individual's decision to spend h hours working results in a related decision to spent d-h pursuing leisure activities. As the marginal income from working for an additional hour is also the marginal value of an additional hour of leisure, the opportunity cost of forgone leisure time is equal to the prevailing hourly wage rate (Becker, 1965; Just, Hueth, & Schmitz, 2005).

Valuation according to prevailing wage rates has strong theoretical foundations, makes use of readily available data and is relatively straightforward. However, the average wage (or a fraction of it) can only be a sound representation of the value of time if a number of assumptions hold true. First, using the wage rates as a proxy for the value of leisure requires that individuals are able to freely adjust the hours they work for (Heckman, 1976). In many cases, this assumption is unrealistic as the number of hours individuals can work for is usually predetermined (e.g. 37.5 hours a week) (Zabel, 1993). Additionally, in its simplest form the model assumes that individuals do not derive any utility from their work (Feather and Shaw, 1999; Bockstael, 1987). Equally importantly, estimating proxy wage rates is difficult for individuals for whom there is no observable wage (e.g. unemployed, pensioners etc.) (Bishop & Heberlein, 1979).

Attempts to move away from the restrictive assumptions associated with the use of wage rates to reflect the opportunity cost of leisure time can be seen in various fields, perhaps most prominently in the economics of transportation and recreational activities (Jara-Díaz & Rosales-Salas, 2017). Valuations using revealed preferences (i.e. preferences construed from observations of individuals' actual purchasing behaviour) and stated preferences (i.e. preferences inferred from individuals' answers to hypothetical choices) exist in the literature. For example, in transportation, the interest in obtaining estimates of the value individuals place on savings in travel time has led researcher to seek revealed preferences of individuals in situations of time–money trade-offs. In this context, Fezzi and colleagues (Fezzi, Bateman, & Ferrini, 2014) looked at choices between free access and toll roads (which save time but require a payment), in order to provide an estimate of the value of travel time. In recreational demand models, researchers have used stated preference (including contingent valuation and various empirical formulations) to elicit the value of time spent on leisure activities (Dalenberg, Fitzgerald, Schuck, & Wicks, 2004; Feather & Shaw, 1999; D. M. Larson & Shaikh, 2004).

Despite this, available guidance on economic evaluation of health care interventions in adults suggests that, in the absence of better approaches, the value of leisure time can be approximated by the average wage, or some proportion of it (Dranove, 1996; Posnett & Jan, 1996). For example, Posnett and Jan (Posnett & Jan, 1996) highlight that the cost of lost leisure time needs to be accounted for when valuing the loss of time in both the employed and the unemployed, and explain that the key challenge in doing so is to choose an appropriate market wage. For those who are employed, the appropriate

value is the net wage rate, whereas for those who are currently unemployed, one needs to identify a value that reflects their potential wage rate.

Naturally, by considering leisure as an alternative to employed work, these approaches focus on working-age adults. At the same time, in cases where employed work is not an alternative to leisure in children, representing the value of children's leisure time using hourly wage rates lacks a convincing justification. An alternative way of obtaining a monetary value of leisure may involve asking how much an individual is willing to pay (WTP) for an additional hour of leisure time through contingent valuation (Sendi & Brouwer, 2004) or inferring this value through answers to choice experiments. Such methods have been extensively used to obtain adults' preferences and monetary values for goods and services not traded in the market; however, it is unclear—or doubtful—whether they can be used to elicit monetary values in children. Indeed, researchers have often questioned the extent to which children have the cognitive capacity (Valkenburg & Cantor, 2001) or experience to understand and answer a question about WTP (OECD, 2006). Despite these reservations, recent research has offered some tentative signs that children can engage in such valuation exercises. In a recent study aiming to estimate children's WTP for reductions in the risk of asthma attack in Italy, Guerriero et al. (Guerriero, Cairns, Bianchi, & Cori, 2018) concluded that participating children aged 7–19 years understood health risk information and were able to make trade-offs between money and health risk reductions. Such findings raise the possibility that preference elicitations exercises may offer a viable valuation method of leisure time. Overall, while research on the valuation of leisure time has attracted significant interest across different areas of enquiry, there is an evident lack of insights into feasible, let alone rigorous methods for valuing loss of leisure time in children.

3.4 Valuation of absence from formal education

Literature searches in PEDE yielded a limited number of studies that valued the opportunity costs of children's absence from formal education. Table 1 summarises seven studies that explicitly valued opportunity costs of the foregone activity and describes the reported method of valuation by breaking it down into different analytical components. Such components are (i) the activity that the investigators identified as having been given up; (ii) the method of measuring the time loss from foregone activities; and (iii) the method by which time loss was valued.

Contrary to studies that have focussed on adults, three main techniques have been used to value the opportunity costs of children's absence from formal education. The first approach bases opportunity costs of school absence on school funding that is lost due to that absence, on the premise that institutions in some jurisdictions are paid on the basis of attendance rather than enrolment (Noyes et al., 2013). Clearly, this approach focuses on revenue losses borne by educational institutions and, as such, it is highly questionable whether they provide a good estimate of the wider opportunity costs associated with loss of children's education time.

An alternative approach assumes that a day of missed school can be valued using an estimate of the daily wage rate of the primary caregiver or using the mean national daily wage rate (Weiss et al. 2006; Sullivan et al. 2003; Buxton et al. 2004). Authors have justified the use of this approach by arguing that it ensures consistency with evaluations conducted in the adult context and consequently that children are not biased against in decision-making processes that assess the relative value of multiple interventions across multiple population groups. Nevertheless, decision-makers, such as the National Institute for Health and Care Excellence (NICE) in England, are willing to weight units of health gain received by some population groups, such as those close to the end of their lives (NICE, 2009), and there appears no methodological constraints to weighting components of the cost calculus towards particular population groups. The first Washington Panel had recommended that the opportunity costs of children's time could provisionally be based on *"the wage rate of teens in the labor force and adjusting as necessary for the selection bias of using observed market wages for teens not in the labor force"* (Gold, 1996), regardless of the particular category of time use. However, we found no applied economic evaluation that valued children's time use in this way. Moreover, the recommendation of the first Washington Panel has been criticised for valuing children's time as *"close to nothing in comparison to adults' time"* (Brouwer et al., 1998). In contrast, the more recent second Washington Panel made no specific recommendations on how to value alternative uses of children's time. Rather, the panel recommended that the time resource of patients in general should be valued at the marginal post-tax wage rate plus fringe benefits, which may be a reasonable approximation for adults but is clearly inapplicable to valuing children's time.

In the third approach, absence from formal education is linked to educational attainment and, in some cases, to potential future earnings. A desirable property of valuations arising from the use of this method is consistency with the human capital approach. There is a plethora of studies from the education literature that demonstrate an association between school attendance and achievement, both at primary school and at secondary school (Bell et al., 2017; Gottfried, 2010, 2011; Stanca, 2006). These studies rely on individual-level population-wide panel data on school absences, school performance, and other educational outcomes of interest. However, extensions that examine long-run effects on labour market outcomes, such as earnings, which might in turn provide evidence on the long-run consequences of absence from education, are rare to find. Longitudinal cohorts rarely provide information on all variables of interest at the individual level. Furthermore, the follow-up period needs to be long enough to generate a reasonable approximation of life-cycle earnings.

A rare example is a recent study by Cattan and colleagues (Cattan, Kamhöfer, Karlsson, & Nilsson, 2017) who combined historical records and administrative data for Swedish individuals born in the 1930s and examined the effects of primary school absences on shorter-term academic performance and long-term socioeconomic outcomes. The authors (Cattan et al., 2017) observe a negative correlation between primary school absence and final educational outcomes and income. In the absence of national longitudinal or linked administrative data on the variables of interest, some analysts have resorted to

a two-stage process to generate an estimate of the long-run opportunity cost of time in education (Miller et al., 2013). The first stage uses national or survey data to explore the association between the measure of educational absence of interest and educational attainment, whilst the second stage used national earnings data to estimates the relationship between the educational attainment variable and average life-cycle earnings. The approach is constrained by a paucity of reliable data on all variables of interest and, by necessity, it draws heavily upon historical data that are unlikely to reflect the experiences of today's generation of children.

In addition to economic benefits, there is now a well-established body of literature pointing to the existence of broader, societal benefits—such as the potential for crime reduction (Machin, Marie, & Vujić, 2011) and increased social participation (Lindsay, 1984; Machin & Vignoles, 2005)— from investment in children's education (Lance, 2011) and health (Case, Fertig, & Paxson, 2003). This has given rise to conceptual frameworks illustrating the potential paths between investment in health, education, and short and long-term socioeconomic outcomes (Belli, Bustreo, & Preker, 2005; McMahon, 1998). Such frameworks serve to delineate the possible channels through which benefits are diffused; however, as Belli and colleagues (2005) point out, establishing links of causation between investment in childhood health and long-term benefits through empirical research, let alone quantifying these benefits with some degree of accuracy, is complex.

It must be noted that attempts to translate children's education and leisure time losses into monetary terms for incorporation into economic evaluation are inevitably framed within a (somewhat narrow) economic paradigm. Beyond this, there exists a wide body of literature on the value and importance of education (and play time) in children, drawing on contemporary theories of children's development, psychology and sociology. Child development specialists have also emphasised the symbiotic effects of education and play in children's cognitive, emotional, social and physical development and growth, irrespective of whether deficits in education or play are associated with quantifiable time losses, such as school absences (Bellman, Byrne, & Sege, 2013; Esteban-Guitart, 2018). It is possible, therefore, that an emphasis on valuing education and leisure time losses will fail to capture sequalae arising from subtle changes in patterns in educational or play behaviour.

4. Discussion

Economic evaluations carried out to provide evidence on welfare changes resulting from treatments, policies or interventions ought to ensure that their calculations take into account all relevant costs and benefits. The wide agreement in favour of including 'time-related' costs in economic evaluations is reflected in the increasing literature on the measurement and valuation of such costs, though most of the interest has been concentrated on the opportunity cost of (productive and to a lesser extent leisure) time in working-age adults (Krol, Brouwer, & Rutten, 2013; Sendi & Brouwer, 2004). Insights into the measurement and valuation of children's forgone time have been scant, and appear to be based

on 'schools of thought' and approaches that are not designed to take into account the characteristics and particularities of this age group.

It is reasonable to think that useful insights may be drawn from other areas of economics. While 'schools of thought' found in the broader economics literature are a good starting point, these are often not specific, or at least not applicable, to children. Commentators have often pointed out that children are almost absent from economic theory, despite their significant role in everyday life (Cook, 2008; Zelizer, 2002). Indeed, children have not been typically treated as economic agents, which may be due to their lack of purchasing power (Cook, 2008; Levison, 2000).

A number of considerations need to be taken into account in relation to measuring and valuing children's time. A schematic representation of these is given in Figure 1. Firstly, the analyst needs to consider whether the inclusion of time related costs is likely to offer useful information that could be helpful for decision-making. Pertinent questions relate to the relevance of this inclusion to the perspective adopted by the study, whether these costs are likely to be salient or negligible, whether there are reasons to believe a new intervention is likely to impact on these costs, as well as whether these costs are likely to be duplicated or captured in other parts of the evaluation. In cases when a decision to include such costs is made, further considerations will naturally relate to the design of the data collection exercise, including the tools to be used and the frequency of data collection, keeping in mind the responder's capacity to process and recall information. Time diaries and novel time use monitoring technologies are seen as an effective and rigorous way of capturing information on the allocation of time (Chatzitheochari et al., 2018) and have been often used to collect and analyse data on children's daily activities (Huston, Wright, Marquis, & Green, 1999). However, prior to deciding on a particular data gathering approach, researchers will need to consider the degree or granularity and accuracy needed in their analysis, given the additional cost of doing so and the potential burden imposed on respondents. Collected data are expected to form the basis for the valuation process. Here, depending on the forgone time to be valued, the analyst will have to consider alternative approaches (such as use of proxy values or direct elicitation), again, keeping in mind that acceptable (or customary) approaches to valuing adults' time are unlikely to be applicable to children.

|Please insert Figure 1|

Attaching a monetary value to children's time is not only the most challenging part of this process, but also the least well researched. Indeed, our searches of the literature revealed very little guidance on assessing the monetary value of lost childhood education and leisure time, and suggested that existing approaches are largely unsuitable for this purpose. Clearly, there is a need for valuation approaches that are specific to children. However, devising an approach to valuing time losses in children is bound to be particularly challenging. Such an approach will need to be practical, consistent with existing theories on time allocation, amenable to empirical investigation and able to reflect the intrinsic value of children's lost education and/or 'play' opportunities.

Further challenges will also need to be addressed, including the question whether, and in which cases, the valuation should be extended to include time spent in ill health. On the one hand, ill health, too, results in time loss, though, on the other hand, such an expansion would effectively make time-loss valuations potentially relevant to virtually all economic evaluations. To judge whether the consequences of time lost to a child being ill are relevant in a particular evaluation, we suggest that analysts consider the extent to which the assessed interventions are likely to have a discernible differential impact on the loss of time due to the child's ill health. For example, excluding the opportunity cost of time spent on ill health from a particular evaluation will be more defensible when there is neither an expectation nor a plausible mechanism through which an assessed programme may lead to a shorter or longer period spent in ill health. Equally importantly, careful consideration should be given to whether, and to what degree, these consequences may be already captured in analysis, with a view to minimising the risk of double-counting. For instance, in economic evaluations such as cost-utility and cost-effectiveness analyses, the benefit of an intervention resulting in patients recovering faster and spending less time in ill health may already be reflected in outcomes, especially when the latter include domains that one would expect to be affected by loss of time, such as ability to carry out usual activities. Additional methodological considerations relate to defining the boundaries between education and leisure, expanding the question to consider the value of other non-discretionary uses of children's time (e.g. help with housekeeping, caring for a pet etc.) and ensuring that wider societal and economic benefits accruing from reduced loss of play and education time are, as far as possible, considered and reflected in the valuation. While these challenges may seem to be substantial, all things considered, they are not expected to be more compelling than other issues health economists have faced, and largely addressed, over the years. As an important first step, challenges and gaps need to be clearly pinpointed, highlighted and brought to the attention of the broader research community.

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Table 1. Summary of identified studies

Authors	Study objective	Activity forgone	Time data collection method	Valuation of foregone time
Miller, Hallfors, Cho, Luseno, & Waehrer, 2013	To assess school support as a structural intervention to prevent HIV risk factors among orphan girl adolescents in Zimbabwe.	Absence from formal education due to school dropout.	Direct identification of time spent away from formal education through i) collecting student survey data, and ii) tracking school administrative data.	Rate of return to education expressed in annual per capita income. Previous published studies estimated that completing four years of secondary education in Zimbabwe increased annual per capita income by 28.2%. Authors assumed a constant rate of return per year of high school.
Noyes et al., 2013	To examine the cost-effectiveness of the School-Based Asthma Therapy (SBAT) programme compared to usual care.	Number of school days missed.	Time data (number of missed school days) collected through monthly telephone interviews	Costs of school absence valued on the basis of school attendance fees losses (using the weighted average daily attendance rate of $40 per absent day).
Weiss et al., 2006	To examine the cost-effectiveness of early treatment with budesonide Turbuhaler in asthmatic children who participated in the START study.	Number of school days missed.	Time data (number of missed school days) collected through follow-up visits at health centres.	School absence valued as equal to a day of lost wages.
Willems et al., 2007	To compare a nurse-led telemonitoring programme with usual care in a population of asthmatic outpatients.	Number of school days missed.	Time data (number of missed school days) collected through cost diaries.	School absence valued according to government costs and (voluntary) parental contribution. Costs depended on school type and class. The total cost was calculated by multiplying the hours of school absence by the corresponding unit costs.
Sullivan et al., 2003	To estimate the incremental cost-effectiveness of budesonide treatment in early onset mild asthma, as observed within the START study	Number of school days missed.	Time data (number of missed school days) collected at each scheduled follow-up health visit.	School absence valued by using an estimate of the daily wage rate of the caregiver.
Buxton et al., 2004	To estimate the country-specific cost-effectiveness of early intervention with budesonide in mild asthma	Number of school days missed.	Time data (number of missed school days) collected through self-reported forms at scheduled follow-up health visits.	School absence valued using wage rates.
Vally, Dowse, Eastwood, & Cameron, 2007	To define the direct and indirect costs associated with chickenpox infections in young children	Number of child care days missed.	Time data (number of missed school days) collected through a questionnaire administered by phone	Absence valued according to child care centre daily fee.

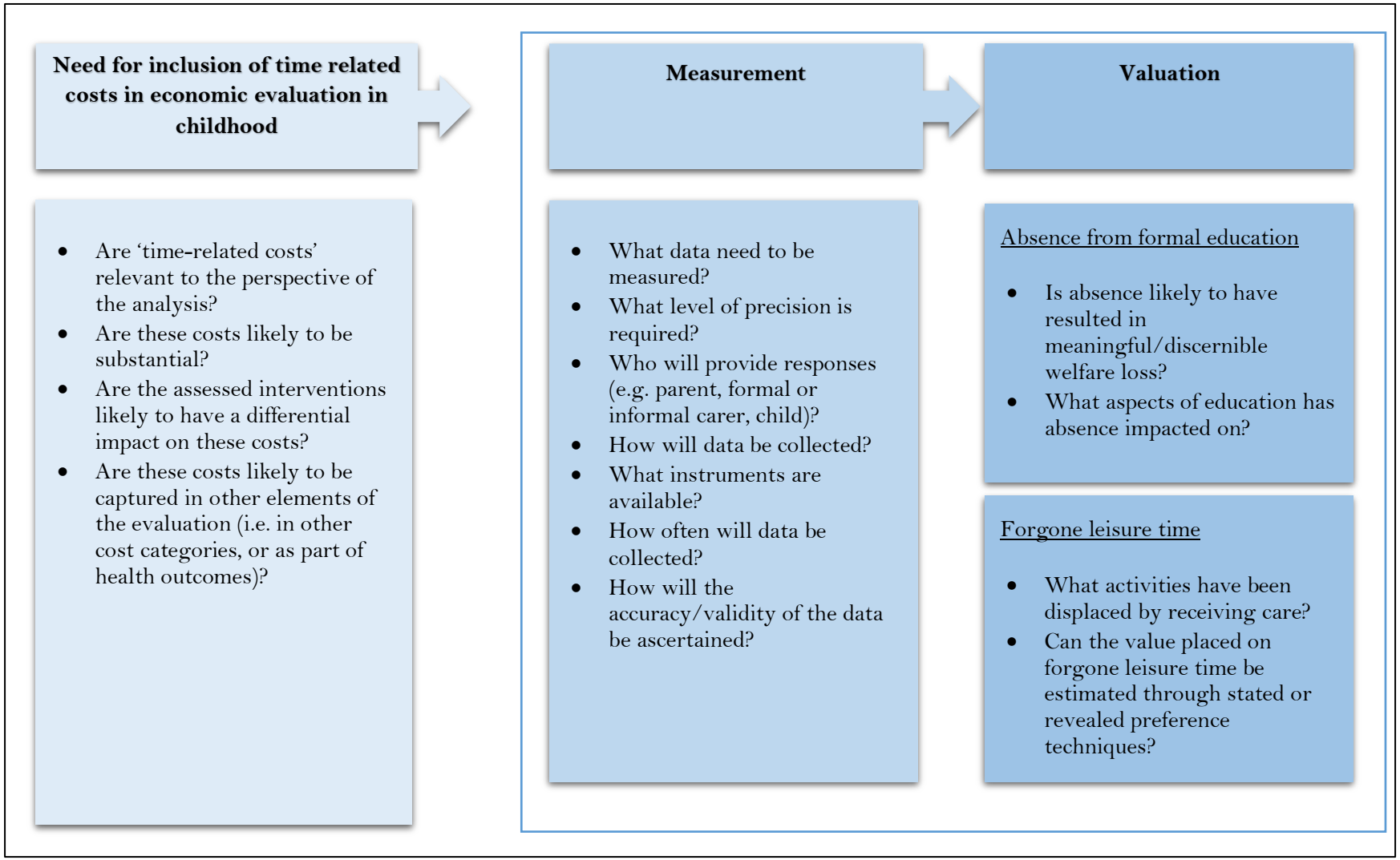

Figure 1. Considerations for identifying, measuring and valuing loss of time in children.

Electronic Supplementary Material

Search strategy: combination of terms used.

# 1.	“absence”
# 2.	“school absenteeism”
# 3.	“student attendance”
# 4.	“pupil attendance”
#5.	“school non-attendance”
#6.	“missing school”
#7.	OR (#1- #7)
#8.	leisure
# 9.	"leisure time"
# 10.	"leisure activit*"
# 11.	"spare time"
# 12.	"spare-time"
#13.	"spare moment*"
#14.	"free time"
#15.	"free-time"
#16.	"idle hour*"
#17.	"time off"
#18.	"non-working time" or "non-working hour*"
#19.	"after-work"
#20.	OR (#8 - #19)
#21.	value*
#22.	“opportunity cost”
#23.	cost*

#24. monetary valuation*

#25. valu* n3 monetary

#26. valu* near/2 monetary

#27. “time-related cost*” OR “time related cost*”

#28. “time-related near/2 cost

#29. “earning*”

#30. “labo*r market*

#31. OR (#21- #30)

#32. economic* evaluation*

#33. economic* analys*s

#34. cost effect*

#35. cost-effect*

#36. cost benefit*

#37. cost-benefit*

#38. cost utilit*

#39. cost-utilit*.

#40. cost consequence* analys*s

#41. cost-consequence* analys*s

#42. cost minimi#ation analys*s

#43. cost-minimi#ation analys*s

#44. economic* aspect*

#45. health care cost*

#46. cost analys*s

#47. OR (#32 - #46)

#48. AND (#7, #20, #21, #47)