

Longitudinal and Life Course Studies: International Journal

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Editorial: Longitudinal and Life Course Studies

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Starting a new journal is like elbowing your way through a crowded room – you know you have a place to get to and a job to do, but if there are so many people already there, are you really needed? There are thousands of journals available to publish papers written by academics across the world. They report research, supply a platform for new ideas, or offer the opportunities for the critical appraisal of other work and book reviews.

The case for a new journal must rest on the fact that there is currently no other journal supplying an opportunity for dissemination in a particular area of research and theory development – a niche to be filled. The Trustees of Longview reached the conclusion that this was the case in relation to the twin themes of longitudinal research and life course studies. The Nuffield Foundation then agreed to support the development phase of the journal through a three-year grant to Longview.² Longitudinal research is founded on a set of principles and procedures directed at yielding insights into possible causal connections among social, biological and developmental phenomena. Life course study reflects the loosening of disciplinary boundaries in the fields particularly of psychology, sociology, economics and history, to reflect the growing recognition that the developmental pathways and transitions through which the human life course is constructed are shaped by multiple influences, including the historical era in which development begins.

A recognition of the effects of social change moves developmental science away from the focus on fixed biological mechanisms in developmental processes towards the changing institutions, social structures and other contexts in which such mechanisms operate. Reports of life course studies will be found in various outlets such as classic books and papers in a variety of academic areas, ranging from health to economics. *But there is no one location devoted exclusively to longitudinal and life course study treated as a field of study in its own right.* Longitudinal research is the vehicle par excellence for mapping the changing human life course within a generation as development and ageing proceed. And through repeated longitudinal studies starting in different historical periods, life course

¹ Short biographies of all the Editors are included at the end of the Editorial.

² Longview (www.longviewuk.com) is an independent think-tank based in London, established for the development and promotion of longitudinal research and life course study and improvement of communication among those engaged in and using longitudinal research.

study offers the means of showing how the life course is both shaped and re-shaped through the interactions between changing societal circumstances, and individual and collective agency.

The 'Class of '68', 'The Baby Boomers', and 'Children of the New Century', express the popular aspect of this conception. Everybody knows that there are continuities from one generation to the next, but each generation brings something new to the scenario in helping to shape what the future of society and the lives of individuals in it are going to be like. Life course study thus targets an area of knowledge that, with the advent of ever more large-scale longitudinal studies in countries across the world, is increasingly realising its value to science, policy and practice. At the same time, new developments in measurement, ranging from genotyping to the quality of community life and the growing potential for linkage to large administrative databases, offer opportunities for enhancing and transforming the knowledge base. Such enhancements support the argument for a new vehicle for the dissemination of research findings.

Many of these new developments in longitudinal study raise significant methodological, as well as ethical, challenges, for example:

- Longitudinal research design often involves both national population samples and area studies. How do we best combine their findings?
- Identification of key developmental variables and the way they are measured has shifted over time, so are historical data as valid as data collected now to study current theoretical concerns and policy needs?
- How can drop-out from a longitudinal study (attrition) best be prevented prior to data collection? How is the potential bias resulting from such 'sample attrition' best compensated for by weighting and statistical imputation?
- What ethical principles should govern linkage to a longitudinal data set of personal data supplied for government purposes?

In developing *Longitudinal and Life Course Studies (LLCS)*, the Editors are seeking, not so much definitive answers to these questions, as to stimulate a vibrant dialogue across the scientific disciplines that will enable more effective research to be done. The Editors will be looking, among other things, for papers and short articles that bridge the academic disciplines in bringing multiple perspectives to bear on topics ranging from pre-natal development, to the quality of ageing in an ever extending lifespan. Alongside the substantive focus the journal is also interested in methodological developments that challenge past assumptions, and offer innovative solutions to old and new problems. Papers addressing ethical issues concerned with data collection, data protection and disclosure – especially with respect to data linkage – will also be of interest. We welcome the widest possible range of papers within the broad framework that the journal offers. The range of subjects covered by the journal has been structured, for purposes of Editorial oversight, into four sections: **Developmental and Behavioural Sciences** (*Barbara Maughan*); **Health Sciences** (*Michael Wadsworth*); **Social and Economic Sciences** (*Robert Erikson*); **Statistical Methodology** (*Harvey Goldstein*). Below, the four Section Editors set out their personal perspectives on the kinds of topics their section will address.

Developmental and Behavioural Sciences

In many ways, developmental studies are at the core of the life course perspective: understanding how and why individuals develop and behave as they do is what life course studies are all about. At times, 'developmental' research has been thought of as

synonymous with the study of children's development, or at best with studies of development in childhood and adolescence. *Longitudinal and Life Course Studies* will of course be delighted to publish papers that focus on these early developmental periods – but we interpret the concept of development in a much broader way. First, we see development as continuing throughout the life course: key developmental changes can and do occur throughout adulthood, as well as in the early years, and we are keen to publish reports of work that tracks such changes whenever they occur, and highlights the influences that prompt them. Second, increasing numbers of longitudinal studies now have data that trace participants from the earliest stages of development, well into the adult years. Results from such studies have proved hugely influential, highlighting both continuities and discontinuities in development, and underscoring the cumulative influence of early conditions and experiences on development much later in life. *Longitudinal and Life Course Studies* is pleased to be among the growing number of journals that particularly welcomes reports that span these different phases of development.

Recent research in the behavioural and developmental sciences highlights many other trends – in particular, the ways in which increasingly sophisticated work within individual disciplines is being complemented by a real burgeoning of interdisciplinary approaches. Although psychological perspectives lie at the heart of much behavioural research, many of the most exciting new developments are stemming from interdisciplinary collaborations of this kind. On the one hand, for example, links with other social science perspectives such as sociology, economics, geography and social ecology are enabling ever-richer explorations of the ways in which proximal and more distal environmental influences interweave to affect development; on the other, collaborations with the biological sciences including genetics, physiology and epidemiology, are allowing us to map the ways in which social experience 'gets under the skin', and both affects, and is affected, by the biological substrate. *Longitudinal and Life Course Studies* is especially keen to provide an outlet for reports that view development from multiple perspectives, and highlight both the new insights and the new challenges that this entails.

Finally, as outlined earlier, the life course approach pays particular attention to the ways in which changing social conditions influence individual trajectories of development. For longitudinal researchers – often steeped in detailed knowledge derived from an individual cohort study – comparisons with other cohorts, whether across time or place, raise fascinating possibilities. Do taken-for-granted risk or protective factors, work in similar ways in different samples studied in different periods? Do our assumptions about the links between environmental influences and developmental outcomes hold when environments are subject to radical change? Have levels of well-being or less favourable developmental outcomes changed across the generations – and if they have, what has prompted those changes? To date, we know extraordinarily little about the answers to those questions, yet they are crucial ones in an era of rapid social change. Once again, *Longitudinal and Life Course Studies* is especially keen to promote cohort comparative studies, and to provide a forum where investigators can share findings in this rapidly expanding area of developmental research.

Health Sciences

Expansion over the last decade in longitudinal and life course health studies has been considerable. Concepts that require longitudinal and life course data are rapidly developing, and studies, both old and new, which collect data for investigation of life course processes throughout the life cycle from the earliest time of life through adolescence and mature adulthood to old age, have flourished. Fundamental to this expansion are new concepts of development and ageing that integrate physical, genetic and psychological influences, and implicate environmental and behavioural influences and their interaction with genetic endowment in the activation and deactivation of genetic effects.

Investigation of these new concepts has become possible largely because measurement has become more accurate, and better developed for use in large scale studies. These improvements range from measures of the physical environment (from nutrition to atmospheric pollution and their effects on the health of individuals) and of biological function and integrity (from blood flow to brain and sensory function, and skeletal health), to genetic measures that can be taken from easily collected biological samples. Ideas about what can be measured and what is important for health have been expanded across a wide spectrum in the psychological and social sciences, from temperament, memory and individual well-being to social cohesion.

Increasing ingenuity in the search for opportunities to research these concepts has made it possible to study significant impacts on health across the life course of individuals, and on inter-generational differences in health. Among the most striking examples are the study of the population that experienced the siege of Leningrad, the study of recovery in children who had been in Romanian orphanages, and the study of Swedish harvests and their association with inter-generational longevity. Furthermore, new longitudinal research is concerned with the effects of national upheaval and insecurity on population health and survival. These studies should now be extended to investigate the cohort effects of national disasters and wars on the mental as well as the physical health of individuals. Social change and differences between and within nations and societies (for example economic, opportunity and life style changes as well as change in the physical environment) offer quasi-experimental opportunities for life course research.

Renewed investment is now being made in several countries in the resource of long-established longitudinal studies that began in early life or in middle life, so that they can make unique contributions to the longitudinal study of processes of ageing in the individual. Investment in new longitudinal studies of early life in a number of countries will help reveal the role of genetics in developmental processes. The large scale and scope of these new and renewed investigations, and the data they offer for comparisons of life course processes at different historical times, provide important opportunities for social scientists and human biologists.

Longitudinal and Life Course Studies intends to stimulate new thinking and new research, and seeks original reports of findings and ideas from across the wide spectrum of health science research, in particular reports of new interdisciplinary work.

Social and Economic Sciences

The individual life course starts in the family of origin and develops through a series of events and decisions with regard to education, family and jobs. In recent decades we have witnessed large changes in these respects. Women have become more active in the labour market, young people opt for more education but have recently met with difficulties in getting jobs, and partnerships are more easily formed and more often dissolved than before. What life trajectories do people typically experience today and how, more precisely, have life courses changed in the post-war period? Which individual outcomes, in terms of class positions, health, economic conditions, and family circumstances, do different trajectories lead to and how has recent societal change influenced individual life chances?

Individual welfare is determined in a process where individual action is structured by societal institutions. In the present-day world, five such institutions make up the basic context within which individuals act – *family, school, labour market, work organisations and welfare state*. Which choices people make and how these choices are constrained, are strongly influenced by the class position of the family of origin and by the gender system, as well as by the individual's position in the social structure.

Two related processes influence social change. One is the aggregation of individual life trajectories; the other is the succession of generations. For instance, the decrease in the number of housewives came about through both these processes: first by an increase in labour force participation among former housewives, i.e. by intra-cohort change, and second because progressively fewer young women became housewives compared to the

number that retired and died, i.e. by cohort replacement. A change in people's conditions and scope for action will affect their behaviour and this will modify the institutions, whereby the change may become reinforced.

Institutional change influences the likelihood of particular events and the opportunity sets for individuals. The choice between education and getting a job becomes different when both the school system and job markets change. The economy of households changes when more goods and services must be bought in the market, two family incomes become standard and some welfare provisions and income transfers emerge while others disappear. These changes may turn out as even more critical for the individual when family membership becomes more volatile and single-parent families become more common. In all these and other respects we know that changes have occurred, but we know fairly little about how they interact and what precise consequences they have for the individual's life course and level of living. In particular we know much too little about how changes in individual behaviour depend upon alterations in institutional structures. The connection between education and work is thus no longer a question of simple consecutive developments; for many people, spells of education and of gainful employment alternate. This process is also closely related to family dynamics, notably for women.

We expect to receive contributions from research touching on issues like these in *Longitudinal and Life Course Studies*.

Statistical Methodology

The analysis of longitudinal data on individuals faces some special problems that may require more complex forms of analysis than many cross-sectional datasets.

The first set of issues arises from the fact that repeat measurements are made on individuals, so that many kinds of statistical modelling that are used, need to recognise this particular 'hierarchical structure'. The second issue is that of attrition, where individuals selectively become missing, possibly to return, and where in particular the propensity to be missing cannot be assumed random.

Where we have 'repeated measurements data' and where these repeated measurements are related to other variables that may change over time, as in growth studies, there is a substantial literature on how to construct appropriate statistical models. In other contexts we may be measuring 'time to an event' as in event history analysis or survival analysis, and again there is a large literature on how to handle such data. An alternative that is often used when there are a small number of fixed 'occasions' or 'sweeps' is to form a series of conditional analyses where variables at later occasions form responses with earlier occasion variables as predictors. One of the problems with such formulations is where dropout or attrition occurs and this introduces the next issue.

When an individual drops out of a study, their subsequent measurements (unless they return) are unavailable. If such individuals are simply dropped from an analysis then this is not only inefficient, it may also lead to biases if the reasons for dropout are non-random, or at least cannot be explained in terms of previous measurements. The issues here involve weighting adjustments and imputation, in order to try to deal with the problems, and imputation techniques are discussed in the paper by Goldstein in this issue.

Of course, there are further issues such as those of measurement errors, which pertain to cross-sectional as well as longitudinal studies. Procedures for handling these have become increasingly sophisticated as have other procedures such as those to handle latent variable models. The journal welcomes the use of such procedures where appropriate, but because of its general readership, their description and interpretation needs to be made very clear as well as the justification for their use.

The journal is also open to papers that seek to introduce novel methodology in this area, possibly used elsewhere and which may not be familiar to readers of the journal. All papers submitted will be scrutinised for their methodological soundness and, where necessary, authors will be offered positive suggestions for employing appropriate techniques.

Quality

The four sections of the journal's extensive subject range, define very broadly the journal's content areas. Papers will be welcomed in these areas and spanning them in more wide-ranging interdisciplinary enquiries. Apart from *relevance*, the overriding principle governing their acceptance for publication is *quality*, as assured in accordance with the standards of peer review. A large editorial board has been established comprising leading experts from across the world in the academic areas and disciplines to which the journal relates. These colleagues will provide reviews of the bulk of the papers submitted to the journal, though other experts will also be drawn into the review process as required. The means of ensuring that the review matches the needs of the papers submitted will be achieved through an editorial structure which comprises the Executive Editor, plus the four Section Editors assisted by members of the Editorial Board who will share with them the choice of reviewers. The final decision about the paper will be the responsibility of the Executive Editor on the basis of the recommendation of the Section Editor (or Editors in the case of papers involving more than one Section Editor).

The word limit (maximum of 7,000 words excluding tables, Figures and bibliography) is more generous than is usual especially in health journals. The loosening of the word length is particularly valuable for reporting multidisciplinary studies and reviews and will widen the appeal of the journal to authors who sometimes find good papers difficult to place.

Accessibility

The second major principle governing *Longitudinal and Life Course Studies* is accessibility achieved through the web-based publication of *LLCS* using the Open Journal System (OJS) through which 1,400 learned journals are currently disseminated. Electronic publication provides quick turnaround from submission of the paper to its on-line availability as a publication. By offering the journal on open access, any paper, or the whole issue of the journal in which it features, can be downloaded at no cost to the reader. In addition, unlike many commercially published journals, *LLCS* will make no charge to authors whose papers are published. By this means the Editors aim to establish the journal as the platform of choice for longitudinal and life course research findings. The newly qualified young researcher, the leading academic who has built his or her career in longitudinal research, the researcher with little access to resources but strong commitment to longitudinal and life course study across the developed and developing world – between them define the community of scholars that the journal will serve.

In addition, the journal will also attempt to develop a readership among policy makers and other decision makers who have an interest in understanding the significance of the messages and findings of longitudinal research and its practical applications.

We therefore look forward to developing a stimulating and exciting new publication, in which there will be continuing and enhanced engagement, for an ever-growing community of scholars and decision makers, in longitudinal research and life course study.

The first issue begins the process with a wide-ranging set of papers, spanning the journal's four sections. Alongside papers reporting research findings, future issues will contain overviews of new longitudinal studies and particular topics such as design options in longitudinal studies and analytic strategies for longitudinal data. Special issues devoted to substantive and methodological topics are also planned.

The journal will also provide a platform for continuing updates in all areas ranging from brief articles on particular studies to news items on the latest data collection. Contributions from around the world will therefore be most welcome. Book reviews will follow in due course.

First Issue

The first issue of the journal demonstrates the disciplinary range and diversity which is central to its mission. There are papers spanning the health sciences, the social sciences and statistics. They encompass different age periods, cohorts and national contexts, displaying the scope of enquiry that is at the heart of the life course perspective. They constitute contributions to knowledge both within disciplines and across disciplines and all have significant policy as well as scientific implications.

The topics covered comprise:

- 'connectedness' within black American communities in North America
- night time bladder control over the age period 4-9 years
- family communications during adolescence and the attainment of financial independence in early adulthood
- obesity as measured by the body mass index (BMI), comparing measures in childhood across cohorts to test the hypothesis that obesity is increasing
- the impact on children's development of employment after child bearing
- handling attrition in longitudinal data using multiple imputation methods

These are just the first examples of what we are confident will be a rich body of life course literature developed through the journal.

Conclusion

Longitudinal and Life Course Studies will fill a major gap in the literature on longitudinal and life course studies. The latest research findings will be made available and a platform for debate provided. The latest news will keep readers up to date about the development of the whole field internationally. OJS publication and our chosen policy of making no charges to read or contribute material, also offers the attractions of free access to researchers and policymakers across the world. We are looking forward to the whole community's support through submission of top quality papers to ensure the journal's success. We also look forward to your feedback about *LLCS* and its contents.

Biographies

John Bynner is Emeritus Professor of Social Sciences in Education at the London Institute of Education and Director of Longview. Until retirement in 2004 he was Director of the Centre for Longitudinal Studies (with responsibility for the 1958 and 1970 birth cohort studies) the Wider Benefits of Learning Research Centre, and was the first Director of the National Research and Development Centre for Adult Literacy & Numeracy. His main research interests lie in economic, social and political socialisation and functioning across the life course.

Robert Erikson is professor of sociology at the Swedish Institute for Social Research, Stockholm University. His research interests concern social stratification, education, family, and health, especially the study of individual change over the life course and how it can be understood with regard to individual and structural conditions. He is a fellow of the Royal Swedish Academy of Sciences, the British Academy, Academia Europaea and honorary fellow of Nuffield College, Oxford.

Harvey Goldstein was formerly Professor of Statistical Methods at the Institute of Education from 1997-2005; he is currently Professor of Social Statistics at the University of Bristol, and a Longview Trustee. He has two main research interests: the first is the use of statistical modelling techniques in the construction and analysis of educational tests with a particular interest in institutional and international comparisons: the second is in the methodology of multilevel modelling. He has been a member of the Council of the Royal Statistical Society, and chair of its Educational Strategy Group. He has been a member of the Council of the Royal Statistical Society, and chair of its Educational Strategy Group and is a fellow of the British Academy.

Barbara Maughan is Professor of Developmental Epidemiology at King's College London Institute of Psychiatry, and a member of the Medical Research Council's External Scientific Staff. Her research interests centre on continuities and discontinuities in emotional and behavioural difficulties across the life course, and on the effects of social change on individual development.

Michael Wadsworth is Emeritus Professor at the Dept of Epidemiology & Public Health at University College London Medical School, and a Longview Trustee. Until 2007 he directed the Medical Research Council's National Survey of Health & Development, the first of the British national cohorts studied since birth, which in this case was in 1946; that study continues now in the MRC Unit for Lifelong Health & Ageing. His research interests are concerned with continuities and discontinuities of physical health throughout the life course, and period and cohort effects of the social and economic environment on health.

Social Connections in the Inner City: Examination across the Life Course

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Abstract

Social connectedness has been shown to be related to health and well-being, yet there is little knowledge about its developmental and intergenerational origins. We examine the childhood, family, and neighbourhood origins of social connectedness in young adulthood in a cohort of African American children (N=1242) from Chicago followed since 1966. The five measures of social connections are: political involvement, organizational membership, church involvement, family ties, and friend ties. In multivariate analyses, predictors of social connectedness were found across the life course: first grade social adaptation to school, childhood family resources, family social participation, adult neighbourhood characteristics, social class, and marital status. We conclude that adult social connections have roots in childhood behaviour and social involvement, family resources and family social connections as well as one's own resources and the neighbourhood where one lives.

Keywords

Life Course Study; Longitudinal Research; Social Connections; Social Capital; African American; Intergenerational; Multi-Level; Neighbourhood; Social Class; Family; Social Adaptation

Supporting Agencies

National Institutes of Health, National Institute of Drug Abuse, National Institute of Aging

Introduction

Although social connectedness has been shown to have beneficial effects on physical and psychological well being, employment, children's development, and the absence of crime (Berkman *et al*, 2000; House, Landis, & Umberson, 1988; Sampson & Laub, 1993; Runyan *et al*, 1998; Furstenberg & Hughes, 1995), there has been limited study of those conditions that lead to social connections. We examine childhood, family, and neighbourhood characteristics that influence social connections in a community cohort of African Americans followed from ages 6 to 32.

Concepts of social connectedness relate to social integration at the broadest level, and to social capital, social networks, social support, and social isolation (Berkman *et al*, 2000). Social ties to others start at the moment of birth and continue to be important for well-being throughout the life course. According to an Institute of Medicine report (2003, p. 64), 13 prospective studies have documented that people who are isolated or disconnected from others are at increased risk of dying prematurely. Social connectedness has also been related to better health behaviours (Umberson, 1987; Berkman *et al*, 2000; Lindstrom *et al*, 2003), less delinquency and criminal behaviour (Hirschi, 1969; Sampson & Laub, 1993), as well as lower unemployment (Kasinitz & Rosenberg, 1996). Several cross-sectional studies, however, have not found relationships between social participation and various measures of health (Ellaway & Macintyre, 2007).

How social connections are protective

Several mechanisms may explain the protectiveness of social connectedness. Social ties help encourage compliance with social norms so that those with many social connections are less likely to engage in behaviours that may be injurious to themselves or others (assuming that the norms favour protective behaviours). This is a major premise in social control theory (Hirschi, 1969). The existence of social ties increases the likelihood that others are able to observe and thus exert pressure. Also, the presence of important social ties helps motivate individuals to regulate themselves (Umberson, 1987). From this perspective, social relationships give meaning and purpose to one's life through the establishment and maintenance of social ties, institutional relationships, and community involvement (Burton, 1998; Seeman, 1996). According to a social capital perspective, social connections provide resources to individuals that can be used to achieve their interests (Coleman, 1988; Portes, 1998). Coleman, an originator of the term social capital, saw youth development as influenced both by the social capital within the family (i.e. the time and investment made in children) and the social capital outside the family (i.e. the family social relationships with other families and community institutions).

In addition, the importance of "weak ties" has also been recognized (Granovetter, 1973). Much of the literature on social relationships has focused on close ties that individuals have with family and friends. However, the advantage of ties with those who are outside one's own immediate circle, "weak ties", allow an individual to reach beyond immediate family and close friends to those outside one's own social circle. Such contacts play an important role in the diffusion of information and resources across society, including links to education and employment. Since "weak ties" are more likely to convey dissonant or new information than are stronger ties with family or friends, they may be particularly important in bringing about individual changes in ideas and behaviours (Granovetter, 1973).

According to Wilson's analysis of inner city areas in the U.S., weak ties may be especially important for those who live in neighbourhoods that are isolated from the mainstream. Wilson (1987) argues that weak ties have diminished over time in inner city areas resulting in disadvantage and social isolation, defined as the absence of social connections. The absence of connections, referred to by Wilson, is not those to family or friends, but to "the lack of contact or of sustained interaction with individuals and institutions that represent mainstream society" (p. 60). Isolation, he argues, increased following changes to policies and laws aimed at dismantling residential segregation. Prior to these changes, African American communities were largely characterized by class heterogeneity such that middle-class professional, working-class, and lower-class families co-mingled within neighbourhoods. Though these neighbourhoods had high rates of poverty and unemployment, those residents who were poor and unemployed still had contact with neighbours who were employed and who interacted with the broader society through their employment or participation in community institutions. The middle class presence in poor African American neighbourhoods, according to Wilson, helped regulate norms, values and sanctions while serving as a link to outside information and resources. With the leaving of middle-class families from the inner city, those who were left behind had fewer connections to the broader society. His argument does not diminish the importance of ties to family and close friends, but rather emphasizes the importance of ties to those outside the immediate social circle, especially for those whose primary social relationships lacked ties to the broader societal institutions.

Predictors of social connections

Few studies have examined the influences on social connections over the life course, whether these connections are to family and friends or to civic activities and organizations. In a longitudinal study,

Myers (1999) found that young adults who had moved less frequently as children, had parents who were involved in church as they were growing up, and had not changed communities for five years had higher feelings of community attachment than others. Graves and colleagues (1998) in a longitudinal study of medical students found that those who had been raised in a family involved in church, had more educated fathers, and did not lose a parent to death or divorce were more likely to have a higher number of group memberships 22 years after medical school. Closeness to parents as measured during medical school was related to later social closeness (indicated by the number of family members and friends that respondents felt they could feel at ease with and talk with). These few studies do suggest that one's social connections are related to the social connections of parents and family members; however, there is no body of literature that demonstrates this.

There has been substantial evidence of generational continuity in education and occupation, (e.g. Blau & Duncan, 1967; Harding *et al*, 2005) yet there has been little study of continuity in social connections across generations. We might expect that those whose parents have been involved in community and civic activities would be more likely to be similarly involved than those whose families have not been involved. Yet, there is relatively little evidence of this intergenerational continuity or little evidence of the continuity in social connections across the life course. Again, we would expect that those individuals who were connected to family and friends and were involved in social organizations at one stage of life would be more likely to be involved at later stages. Despite the important advantages that social connections seem to confer, there has been little study of their continuity across the life course or across generations.

Conceptual framework

Our goal in the present study was to estimate the long-term and developmental influences on young adults' social connections to family, friends, church, organizational ties, and political ties. These connections represent the breadth of ties from close family and friends to the broader societal, civic, and organizational connections. We have hypothesized several pathways to social connections over the life course. One pathway focuses on family social and economic resources. A second pathway centres on the family's own social connections over the life course. A third pathway focuses on the individual's past social connections in earlier stages of the life course (i.e. childhood and adolescence). Finally, the model acknowledges the potential importance of neighbourhood context on social connections. Our conceptual model is one of the first to focus on the causal processes linking family social resources, childhood social connections, and neighbourhood context to social connections in the adult years.

Our study draws on several perspectives: a social field perspective that emphasizes the developmental importance of the relationships that individuals have within important social contexts across the life course (Kellam *et al*, 1975); a life course perspective that focuses on the linked lives of family members noting that lives are lived interdependently (Elder, 1998); and a neighbourhood ecology model that recognizes the importance of one's residential context in influencing opportunities for social connections (Fernandez & Harris, 1992; Oliver, 1988; Rankin & Quane, 2000).

The social field perspective emphasizes the importance of key social fields in individuals' lives. For example, the family and school contexts are key for children; as they mature, peers and intimate partners become important social contexts. Employment, one's own family of procreation, and eventually one's children's families are potentially important social fields. The perspective argues within each of these social fields there are important raters who evaluate one's performance (e.g. the parents in the family, the teacher in the classroom, the supervisor at work), and that these ratings have importance to the individual's adaptation to the current social fields as well as implications for future adaptation in key social fields. It is not that the raters are accurate in some objective sense, but that their judgments have repercussions for the individual. There is some continuity in an individual's adaptation, both across social fields and across time (Kellam *et al*, 1975; Kellam & Rebok, 1992). Thus, we would hypothesize that those who were rated as doing well in social relationships early in the life course would have more social connections as adults.

The concept of linked lives is paramount in the life course perspective as articulated by Elder (1998). Historical events and individual experiences are connected through the family and the experiences of one's family members are shared with others through their relationships. Kinder (2006) argues that political participation starts in the family with parents setting the stage for political discussion. Children acquire (or not) a set of political predispositions and skills that influence their participation later. The most robust finding with regard to family influences on social connections is that children from homes

with more income, more skills, and more education are more likely to take part in all forms of participation (Kinder, 2006; Rosenstone & Hansen, 1993). Here, we would hypothesize that children of parents who are active in community, civic, and religious organizations would be socialized to be active members of these groups. Modelling of parents' behaviours, recruitment by parents, or social training might all be responsible for this hypothesized continuity.

A third influence on social connectedness may be the context where one lives. The opportunities for social connectedness in terms of the availability of churches, and community and political organizations are likely to vary by neighbourhood. In addition, the norms of social connections may vary by neighbourhood. Several studies have documented that neighbourhood characteristics are associated with residents' social connectedness as measured in various ways (Fernandez & Harris, 1992). In a study of inner city Chicago African American families, Rankin and Quane (2000) found modest neighbourhood effects on social isolation, measured by individual and family participation in community organizations and by the composition of the individual's network. Individual-level characteristics, such as socioeconomic status, were the strongest predictors of social network composition and individual and family participation in community organizations. In a study of social networks of African Americans in Los Angeles, Oliver (1988) found those living in the most economically depressed neighbourhoods were more likely to have local ties with neighbours and family members and less likely to have organizational ties. Similar to the "weak ties" concept, Oliver suggests the strength of these local ties may inhibit the building of links to formal groups and those outside their immediate neighbourhood. Most of these studies have been cross-sectional and have not integrated the neighbourhood context with longitudinal information on the family or the prior social involvements of the study participants.

We hypothesize that social connectedness will vary by neighbourhood characteristics. Specifically, we will examine the percent poor in the neighbourhood, the percent black in the neighbourhood and the percent white collar workers who live in the neighbourhood. Neighbourhoods that are poor are less likely to have the resources to support organizations that residents may be involved with. A higher percent of white collar workers in a neighbourhood is intended to be an indicator of a middle class presence, and is hypothesized to be related to higher rates of participation. For African Americans, living in a neighbourhood that has a higher percentage of blacks may indicate a more conducive context to participation. Past research indicating that living in a black neighbourhood may be conducive to the social participation of African Americans (see Bledsoe, Welch, Sigelman, & Combs, 1995). While we expect that percent black and percent poor will be highly correlated, there will be variation amongst neighbourhoods. For example, there will be relatively middle class neighbourhoods that vary on the percentage of blacks that live in the neighbourhood. We would expect that in these cases, those neighbourhoods with a higher percentage of blacks will have higher participation.

Contributions of study

This study examines, then, the influence of family resources and connections, the continuity in social connections over the life course and neighbourhoods on social connections. Given the importance of social connections to a number of beneficial outcomes, a better understanding of what influences their development is needed.

Method

Overall research design

Using longitudinal data from a cohort of children who started their schooling in an inner city Chicago neighbourhood in 1966, we examine the family and individual characteristics related to social connections as an adult at age 32. We also examine how the neighbourhood where one lives influences social connections. We hypothesize that there is continuity in behaviour over the life course, that early family resources and parental social connections relate to later social connections, and that neighbourhood characteristics are associated with social connections in adulthood.

Longitudinal data can help sort out social selection effects on neighbourhood influences on social connectedness. That is, those who live in poor neighbourhoods may have characteristics that would lead to social isolation as well as to living in a poor neighbourhood (Tienda, 1990), a family background of poverty, frequent mobility, or a history of lack of social attachment to family or school could lead to

both social isolation and residence in a poor neighbourhood. Controlling on these characteristics, allows us to observe the relationship between social isolation and neighbourhood while taking into account the early family context.

Participants

The data are from the Woodlawn study, a longitudinal community epidemiological study of a cohort of first graders (N = 1242) and their mothers that began in 1966 – 67 and followed to age 32 (N = 952). Children (and their families) in the first grade classrooms in the nine public and three parochial schools in Woodlawn were recruited to participate in the study. Thirteen families refused to participate. Ten years after first grade (1976), the mothers and their adolescent children were assessed again. In 1992, the former first graders, age 32 – 34, were interviewed as young adults. The study procedures were reviewed by the Bloomberg School of Public Health Institutional Review Board and received their approval. The data from the first two waves have been archived at the Murray Center, Radcliffe Institute for Advanced Studies.

When the study was initiated Woodlawn was one of the poorest of the 76 communities in Chicago with high rates of poverty. According to Census data from Woodlawn and the City of Chicago, 32% of Woodlawn families with children below the age of 18 were poor compared to 15% for Chicago. Woodlawn was mostly African American (96% compared to 33% for Chicago). It was overcrowded with a population of about 81,000 residents in housing units meant for about 50,000 people. Despite the overall poverty in the neighbourhood, there were areas where middle-class families lived and areas of relatively low unemployment and poverty.

By the time of young adulthood, 84% of those who were interviewed (N = 952, 48% male) were living in the Chicago area; only 10% were still living in the community of Woodlawn. Rates of poverty were high within the population with 39% living below the poverty threshold. About 80% had finished high school and 63% were employed. About 36% were married and 61% had children living in their households. However, there was heterogeneity in the population with 10% having graduated from college.

Attrition

In any longitudinal study, there is the question of whether those who refuse to continue to participate or who cannot be found are different than other participants who are found and who consent to be interviewed. In the follow-up of the young adults (in 1992 - 1993), we were able to locate 1038 (84%) of the original 1242 who participated as first graders in 1966 - 67. Of these we interviewed 952. Of the remaining 86 located persons, 44 were deceased, 3 were too physically or mentally incapacitated to be interviewed, and 39 refused consent to be interviewed.

We have compared those who were interviewed as young adults to those who were not on earlier ratings of childhood behaviour, social adaptation, and psychological well-being measured during elementary school years and rated by teachers and mothers and on family measures of poverty, family type, mother's education, welfare status, number of residential moves made by the family, and age of mother at birth of her first child as reported by the mothers in first grade. Those whose families had been living below the poverty line in 1966 - 67 were less likely to be interviewed as young adults. Those interviewed as young adults were slightly more likely to have been living with both parents in first grade as compared to those who were not interviewed. None of the other family background measures were related to interview status, and nor were any of the first grade teachers' behaviour ratings or grades. Adolescent drug use did not differentiate those who were re-interviewed from those who were not.

A main source of missing data for the current study comes from the adolescent data. We only interviewed those who lived in Chicago and whose mothers agreed for them to participate. We were able to interview 939 of the mothers (75%) and 705 of the adolescents. In comparing those who were assessed in adolescence with those who were not, we found few differences. Missingness during adolescence was not related to gender, mother's education, poverty, welfare, family income, or family type during first grade. Nor was it related to depressive disorder, having an official crime record (overall, or for property, violent, or drug related crime), adult alcohol or drug dependence, or marijuana, cocaine, or heroin use during adulthood. It was related to having a teenage mother – those mothers who started childbearing as a teenager were less likely to give permission for their child to be

interviewed. Many methodologists have argued that the seriousness of missing data is exaggerated in longitudinal research (Falaris & Peters, 1998; Fitzgerald, Gottschalk, & Moffitt, 1998). They suggest that while some of the missing is due to bias (as we show above) that most is due to random factors (as we also demonstrate). Our study has the advantage of being able to compare those who are missing in adolescence not only on the early measures, but also on later measures in adulthood as many were re-interviewed in adulthood.

Measures

We use five measures of social connectedness in adulthood: political ties, social ties to organizations, church attendance, social supports from family, and social supports from friends and neighbours. Three of these indicate the involvement of the individual with mainstream organizations or activities (political ties, social organizations and church attendance – indicators of “weak ties”). The other two indicate involvement with more immediate friends and family (See Table 1).

Political ties were measured by questions concerning the political behaviour of the young adult. Respondents were asked whether they were registered to vote, ever voted, voted in a recent election, have ever gone to a political meeting, have ever worked in a campaign, ever participated in picketing, sit-ins, and ever signed petitions or written to elected officials (0 = no, 1 = yes). These items represent increasing involvement in the political process. Someone who has voted would also be registered to vote, and someone who has worked in a political campaign would also have been likely to be registered and to have voted. We used Rasch analysis that provides estimates of item difficulty levels along a unidimensional continuum, scaling them against respondent positions on the latent construct being measured (Rasch, 1983). The assessment of “ever signed petitions or written to elected officials” was a departure from the unidimensional measure, so it was omitted from the scale. The 6-item scale of political ties had a moderately high reliability (Cronbach’s $\alpha=0.76$). Those who are more involved have a higher score, range -4.11 to 3.75. This measure is similar to others in the literature used at about the same time as the adult follow-up (e.g. Danigelis, 1982; Jennings & Markus, 1988).

Social ties to organizations were measured by a series of questions that asked about voluntary community and professional/work organizations that respondents may belong to and whether they participate in the activities of the organization. We focus on those organizations that would be likely to link individuals to others outside their immediate milieu, including (a) professional or labour organizations, (b) civil rights organizations, (c) a national sorority or fraternity, (d) women’s rights organizations, or (e) Veteran’s groups. The yes responses to belonging and to participating, were summed to make an index of social ties ranging from 0 to 8. Due to being highly skewed to the right, we combined the higher ratings (0=did not belong or attend) to 4 (=participated and belonged to more than 4). These measures are similar to those used by others (e.g. Woodward, 1986; Rietschlin, 1998).

Church involvement was measured by asking young adults whether they belonged to church and how often they attended church. The scale ranged from do not belong and never attended church (= 0) to belong and attend several times a week (= 4). Again, this measure is similar to others’ measures of church participation (Ellison & Sherkat, 1995; Stolzenberg, Blair-Loy, & Waite, 1995).

Social support is intended to measure the relationships that individuals can draw upon to cope with daily problems (Berkman *et al*, 2000; Thoits, 1995). Social supports from family and from friends were measured by asking : “To whom you can turn: (a) if you are sick; (b) if you need money; (c) if you have a tough decision to make; (d) if you are sad or blue; and (e) if you have a fight with a friend.” Respondents listed those people they could turn to for each of these. Multiple answers were allowed (i.e. someone could answer multiple family members, friends, neighbours). If respondents listed family members (e.g. father, mother, spouse/partner, brother/sister) and other relatives, the yes responses were summed to make a scale of social supports from family and relatives ranging 0 to 25. Due to highly skewed distribution to the right and wide range of the variable, we used a square root transformation with range of 0 to 5. If they listed friends or neighbours, the yes responses were summed to make a scale of social supports from friends and neighbours ranging from 0 to 10. Because these responses were also skewed to the right, we have combined those with more neighbours and friends into fewer categories. The scale ranged from 0 to 5 (=5+).

Family and individual characteristics in first grade, adolescence, and concurrently in young adulthood were included. *Background family variables* were mother’s education, as reported by the mother at the time of first grade (which was dichotomized as to having finished high school or not) and first grade

poverty, as indicated by whether the family income was below the federal poverty line reported by the mother. Gender was included. Participants were all African American and of the same age.

Social adaptation in first grade was measured by teacher ratings in first grade on five tasks (i.e. achievement, concentration, social withdrawal [shyness], authority acceptance [aggressiveness], and maturity) the teachers considered important for first graders (see Kellam *et al.*, 1975 for issues of reliability and validity of these ratings). Ratings on social contact (shy behaviour) and authority acceptance (aggressive behaviour) are included here because of their special relevance to the issues of social connectedness. Each first grader was rated on these behaviours on a scale from 0 (neither shy nor aggressive) to 3 (both shy and aggressive). These ratings have been shown in past analyses to relate to adolescent drug use and delinquency and drug use in young adulthood (Ensminger, Juon, & Fothergill, 2002; Kellam, Ensminger, & Simon, 1980). Shy behaviour would indicate that the child at the time of first grade was not as involved in social relationships as other children, according to the teacher, and aggressive behaviour indicates that the child related to others in an aggressive or bullying manner, according to the teacher. Adolescent school bonds were assessed by five questions (i.e. how important is doing well in school, how do your teachers think you are doing, how satisfied are you with your teachers' opinion, how far would you like to go in school, and how far do you think you will go in school) about the adolescents' attachments and commitments to school (Cronbach's $\alpha = .68$). This measure was trichotomized into low, medium, and high school bonds.

During adolescence, mothers (or mother surrogates) were asked about both their *membership and their participation in voluntary associations*, and a scale was made that included both the number of associations and their involvement. (This scale is identical to the one described earlier for the young adults). Mothers were also asked about their *church membership and frequency of their church attendance* (again, similar to the scale described above for the young adults).

The young adult's *social class* was defined by poverty level and employment. This definition is consistent with those who emphasize attachment to the labour force as an important feature of class position (Wilson, 1987; Tienda & Stier, 1991; Fernandez & Harris, 1992). Three groups were defined: (a) the working nonpoor were those with a family income more than 150% of the official poverty line and who were currently working; (b) the working poor were those with a family income less than 150% of the official poverty line who were currently working; and (c) the nonworking poor were those with a family income less than 150% of the poverty line who were not currently working.

Frequent measures of social connections used in the literature (Berkman *et al.* 2000; House, Landis, & Umberson, 1988) include marital status and residential mobility. Marital status indicates social connectedness and also facilitates other social involvements. Those who are married have access to the family and friends of their marital partner. Frequent residential mobility can impair the likelihood of the formation or maintenance of friendship and family ties, as well as the participation in community and neighbourhood organizations. The young adults were asked about their current *marital status* (married vs. not married) and how long they had lived in their *current residence*.

Neighbourhood characteristics were based on the 1990 census characteristics of the tract where the study participants lived in 1992. The census measures included the proportion of residents who were black, the percent of those who were below the poverty line, and the percent of those with white collar occupations. We chose percent below the poverty line and percent in white collar occupations because of the importance that the social resources in a neighbourhood may have to opportunities to socially participate. We consider the percent in white collar occupations to be an indicator of how middle class the neighbourhood is. The proportion living in poverty was highly correlated with the proportion of blacks in the census tract ($r = .45$, $p < .001$) and the proportion in white collar occupations ($r = -.53$, $p < .001$). Because of this multicollinearity, we only include the proportion of blacks and the proportion in white collar occupations in our analyses.

Table 1. Reports of Background, First Grade Adaptation, Mothers' Social Connections, Adolescent Social Connections, Adult Status, and Measures of Social Connections

Variables (Time of Measurement in bold)	M or %	SD	Range
First Grade (n=1242)			
Gender			
Male	47.8%		
Female	52.2%		
Mother's education			
0-11	58.2%		
12+	41.8%		
Poverty index			
Poor	51%		
Not poor	49%		
Shy/Aggressive Behaviour			
Neither Shy nor Aggressive	52.7%		
Shy Only	16.1%		
Aggressive Only	16.5%		
Both Shy and Aggressive	14.7%		
Adolescence			
School Bonds (n=705)	1.05	0.83	0-2
Mother's church attendance (n=939)	1.87	1.32	0-4
Mother's organizational membership(n=939)	1.93	1.54	0-4
Adulthood (n=952)			
Social class:			
not poor	44.3%		
working poor	20.1%		
nonworking poor	35.6%		
Marital status			
Married/living with partner	27.9%		
Not married	72.1%		
Length of residence	2.47	1.31	0-4
Neighbourhood characteristics (1990 Census)			
% below poverty (0-94)	27.5	19.1	0-94
% black (0-100)	74.2	35.4	0-100
% white collar job (15-93)	56.7	12.2	15-93
Reports of Social Connections (Outcome variables)			
Political ties	0.31	1.78	-4.11-3.75
Organization ties	1.07	1.26	0-4
Church attendance	1.61	1.34	0-4
Social support, family	2.70	1.02	0-5
Social support, friends/neighbours	1.94	1.88	0-5

Analytical Approach

The research questions are focused on the childhood, family, and neighbourhood predictors of five measures of social connections. The data are longitudinal and nested. For the main analysis we relied on regression analysis using General Estimating Equations (GEE) (Zeger, Liang, & Albert, 1985). We estimate a multivariate model for each of the measures of social connections that includes early family background (poverty, mother's education), childhood behaviours as rated by teachers (shy and aggressive behaviours), adolescent social connectedness (school bonds), mothers' social connections measured during adolescence (church participation and organization involvement), social class in adulthood, marital status, residential stability, and neighbourhood characteristics (% poor, % black, and % in white collar occupations).

The multivariate analyses need to account for autocorrelation between individual-level and neighbourhood-level measures of poverty. We supplemented our individual-level data with information on the neighbourhood (census tracts) where the adults resided. Clustered data is complicated by the correlation that typically exists among observations within the same cluster. The similarities (i.e. unobserved shared environments) among people from the same neighbourhoods are not fully captured by macro-level covariates in regression models. When autocorrelation is present, the independence assumption of conventional regression techniques is violated (Zeger, Liang, & Albert, 1988). To account for this potential lack of independence, we used GEE that relax the assumption of the independence of the nested variables (Zeger, Liang, & Albert, 1988). We were not focused on how much individual level data contributed to the model compared to neighbourhood level data, but rather whether they each contributed to social connections.

We used ordinary least squares regression analysis with our transformed outcome variables (e.g. organization ties, social support from family, social support from friends/neighbours) in order to achieve more normal residuals (Cohen *et al*, 2003). We tested the assumption of constant variance and found that the data were consistent with this assumption.

A multiple imputation procedure was implemented by using MICE in Stata 10 (StataCorp, 2007). A total of 5 imputed data sets were used in the analysis. Imputation models included all covariates from childhood, adolescence, and young adulthood that were related to the missing mechanism and were associated with social connections. Based on a mixture of dichotomous and ordinal variables, we imputed under an assumption of normality and rounded off the continuous imputes to the nearest categories (Schafer, 1997). We compared the results of the multiple imputation (n=950) with that of listwise deletion (n=660) and found the results were comparable; however, the imputed data had lower standard errors, resulting in larger coefficients and smaller *p*-values.

Results

Table 2 shows the results of the full multivariate GEE analyses for the five dependent variables. In terms of family background and childhood behaviour measured at the time of first grade, those whose mothers were more educated were more likely to have organizational ties. Those who were shy were less likely to have organization ties than those who were neither shy nor aggressive ($p=.07$). Those who were aggressive in first grade were less likely to have social supports from family as young adults ($p=.06$). Those who were rated with the combination of shy and aggressive were less likely to have social supports from either friends or family.

In relation to social connections during the young adults' adolescence, higher school bonds were related to higher church attendance as an adult. The mothers' report of their own church membership was related to adult children's higher likelihood of attending church. Mothers' church participation was inversely related to the adult children's political ties, the only finding that was contrary to intergenerational continuity.

Those who were unemployed and poor had fewer social connections by all measures compared to those who were not poor. The employed poor were less likely to report political ties ($p=.08$), organizational ties, and social support from family and friends/neighbours compared to those who were not poor.

Neighbourhood context was also found to be associated with adult social connections. Those from neighbourhoods with a higher percentage of blacks were more likely to be politically involved, to attend

church, and to report social supports from family. Those from neighbourhoods with a higher proportion of residents in white collar occupations were more socially connected on all measures except supports from family.

Individual background variables that served as controls in the analysis were also found to be related to adult social participation. Men were less likely to attend church and to receive social support from friends and neighbours. Those who were married had more organizational ties, higher church participation, and more social support from family. Those with lower residential mobility reported more organizational ties, higher church participation, and more social support from both family and friends.

Table 2. Multivariate Linear Regression Analysis of Social Connections using GEE, b coefficients (n=950)

	Political Ties	Organization Ties	Church Attendance	Social Support family	Social Support friends, neighbours
Individual and Family Background, First Grade					
Male	.03	-.13+	-.21*	-.02	-.37**
Poverty index = Yes	-.03	.03	.12	-.10	-.16
Mother's Education = 12 years +	-.04	.17*	-.05	.06	-.14
Shy/aggressive behaviour					
Shy only	-.14	-.19+	-.17	.06	-.25
Aggressive only	.16	.08	-.07	-.16+	-.08
- Both	.07	.05	.14	-.22*	-.46*
Adolescent social connectedness					
School bonds	.15	.10	.18**	.07	.13
Mother's social connections at Adolescence					
Church membership	-.11*	.04	.12**	-.04	-.02
Organizational membership	.08+	.03	.03	.03	.01
Individual and Family Characteristics, Young Adult					
Married	.06	.45**	.33**	.58**	-.26+
Length of Residence	.08+	.08**	.08*	.06*	.14**
Poverty and Work, Young Adult					
Social class					
Employed poor	-.31+	-.38**	-.05	-.26**	-.46**
Unemployed poor	-.81**	-.59**	-.27*	-.28**	-.43**
Neighbourhood Characteristics					
% Black	.78**	.26	.28*	.23*	.27
% White collar	1.81**	.89*	.82*	-.18	1.32**

Note. +p<.10; *p<.05; **p<.01

Discussion

Continuity across the life course

The findings indicated a continuity in social connections across the life course. Behaviours related to social relationships that were rated in first grade by teachers were associated to later self reports of organizational participation and social supports from both family and friends. It may be that the behaviours the teachers observed in first grade were relatively stable across the life course, and inhibited supportive interpersonal relationships. It is also plausible that these teacher-rated behaviours set the trajectory for reinforcement of these behaviours developmentally. For example, an aggressive child is difficult for the teacher and for peers so they respond negatively to the child, who in turn responds negatively so that the behaviour becomes exacerbated and reinforced as the child develops. These early behaviours were related to later informal ties with family and friends. Shy children were also less likely to participate in organizations as adults. Our findings support work by Newman and colleagues (1997) and Asendorph, Denissen, and van Aken (2008) that found that childhood temperament was associated with adult interpersonal functioning. Specifically, children who were rated as undercontrolled or inhibited (similar to shy) had lower levels of social support as young adults (Newman *et al.*, 1997) and aggressive children experienced more conflict in their relationships with their mothers and romantic partners (Asendorph, Denissen, & van Aken, 2008). In addition, social bonds in adolescence related to church participation as an adult, and indicated that early social attachment to school may help prepare young people to participate later in adult organizations.

The intergenerational continuity in social connections was supported by the findings. Both measures of family participation – the mother’s church involvement and organizational ties – were related to the adult children’s social connections. Given the importance of church participation in the African American community (Ellison & Sherkat, 1995), having family involvement at an early age clearly fosters more integration to the larger community. Family modeling as well as early familiarity with social participation, may have influence on the social connections that children learn and carry on to adulthood. There also was a negative finding here, in that mothers’ involvement in church was *negatively* related to political participation of their adult children. However, mothers’ organizational involvement was related to political participation. It may be that the continuity is specific here so that church involvement relates to later church involvement while organization involvement relates to later secular involvement, i.e. political participation.

In terms of family resources, we had somewhat mixed results. While we did not find childhood family poverty to be related to any of our five outcomes of adult social connections, mother’s education was related to greater organizational ties in young adulthood. We did not examine indirect effects in our analyses and it may be that childhood family poverty was indirectly related to later social connections through its relationship with mother’s education, adult social class or other variables used in the analyses. Elucidating how these early family resources impact on later life is an important area for further research. We know that mothers in poor households and mothers with lower education are more likely to be depressed (McLloyd, 1990; Ensminger *et al.*, 2003) and are more likely to be the only child-rearing adult in the family (Cancian & Reed, 2001). Further, those who are poor can only afford to live in poor neighbourhoods where the quality of schooling may be poor and where social control is lacking (Jencks & Mayer, 1990). This lack of resources may handicap their children in fundamental ways, including their likelihood of participating in both formal and informal relationships.

Adult associations with social connectedness

One’s own resources as an adult greatly influenced social participation. Those who were unemployed but not poor were less likely to report social involvement in all domains except church. Those who were both unemployed and poor were less likely to be socially connected in any domain. One of the underappreciated virtues of economic resources is that they allow participation in civic and voluntary associations and social activities with family and friends that those who are lacking in resources are not as able to easily accomplish. One of the strengths that social capital supposedly brings to children and families is the ability to connect to those who provide opportunities and social resources (Astone *et al.*, 1999). The findings here suggest that, to the extent that social capital is indicated in our measures of social connectedness, social capital is not equally distributed; those who have fewer economic resources are also likely to have less social capital.

Two of the most commonly found predictors of social integration were also evident in these findings – length of residence and marital status. Those who had lived in their current residence for a longer time were more likely to report being socially connected across all five measures of participation. Marriage related to higher organizational and church involvement and more social supports from family, but less social supports from friends and neighbours. Given that current social class and past behaviours were included in these analyses, the results indicate the sturdiness of the marriage and residential stability impact on social connections.

Neighbourhood influences on social participation

The results are also consistent with the importance of neighbourhood context on social connections, even with individual social class included in the analyses. Living in a middle class neighbourhood and living in a neighbourhood that had a higher proportion of African Americans, increased the likelihood of political participation, church attendance and social supports. These may seem to be contradictory results since neighbourhoods with a higher percentage of blacks are less likely to be middle class. However, in this population of all black respondents, there is not a one-to-one correlation between these neighbourhood variables, and middle class neighbourhoods did vary on the percentage of blacks who lived in the neighbourhood. Those who lived in neighbourhoods with a higher proportion of blacks were more likely to report higher social supports from family, while those living in middle class neighbourhoods reported higher involvement with friends and neighbours. (Since these findings are from multivariate analyses, the significant findings control on the other variables in the analyses). The findings are consistent with the social density hypothesis which predicts stronger racial solidarity among blacks who live in predominantly black neighbourhoods (Bledsoe, Welch, Sigelman & Combs, 1995). Blacks with a greater sense of solidarity are more likely to engage in a greater variety of political activities (Gurin, Miller, & Gurin 1980).

Influences on adult family support

Findings from the study indicate the myriad influences on the reports of family support from young adults. First grade aggressive and shy behaviour, being unmarried, being poor and unemployed as an adult, and living in a neighbourhood with fewer African Americans were all related to having less support from family members as an adult. These findings reflect the complexity that is involved in the formation of social bonds to one's family. These findings emphasize that resources not only matter for material goods but also for primary social relationships.

Strengths and Limitations

One of the strengths of the study is the number of sources of information and the prospectively collected data. Teachers reported on the child's behaviour in first grade; mothers reported on the family background in first grade and on their own social connections during their child's adolescence; the cohort members reported on their social connections in adolescence, on their residential and marital status in adulthood and on their social connections in adulthood. Finally, census information was used to characterize the neighbourhoods where the adults lived. The conclusion that there are multiple sources of social connections is strengthened by the findings that reports from all these sources were related to the social connections evident in adulthood.

The design of this study has some limitations in examining the origins of social connections. In terms of our neighbourhood findings, our results may be somewhat affected by social selection issues, that is, more socially isolated individuals may be more constrained or may choose to live in neighbourhoods that do not enhance social participation. Social selection hampers many studies of neighbourhood effects as it is very rare to be able to assign people to neighbourhoods. Since this study is a longitudinal study we are able to control on many of the background characteristics that are thought to affect neighbourhood residence such as a family background of poverty, a history of residential mobility, and current economic resources, but we may not have included all the potentially relevant variables.

The results come from one cohort of children from a disadvantaged neighbourhood followed longitudinally to adulthood. Clearly, there are questions of generalizability. However, the population is an important one in terms of formulations about the social isolation of those who live in poor and segregated neighbourhoods.

Further, there was moderate attrition, especially during the adolescent period. Some of the factors relating to attrition may affect the findings. Those children born to teen mothers were less likely to be assessed during adolescence. There were some indications that teen mothers were more socially isolated – they moved more often, they were less likely to give permission for their children to participate in the study, and their family connections were less stable. These children may have grown to be more isolated as adults and may have been less likely to be interviewed as an adult. However, few other differences were found between those who participated and those who did not.

Implications

Formal participation and informal participation have often been distinguished in the literature. “Weak” ties are supposedly enhanced by formal participation. In our findings, with the exception of the influence of mothers’ social connectedness (which only related to weak ties) there did not seem to be distinct predictors of the two. Otherwise, political, organizational, and church participation were often predicted by the same antecedents as were family and friend supports. There may be more continuity in participation across these domains than has been suggested.

Despite the limitations of the study, this work provides evidence of the complex and multifaceted nature of the origins of social connections. Adult social involvement has many influences over the life course including family resources and family social involvement, past behaviours, current resources, as well as the neighbourhood where one lives. Durkheim’s (1951) classic study of suicide pointed us to the social origins of social integration. These social origins are clear in the current work. However, other influences on social connections are also evident. One’s family history and earlier experiences of social connectedness also enhance social connections in adulthood.

There are several implications for this work. First, the study of social connections across the life course has received little study. Given the importance of social connections both for the individual and for society, a better understanding of how social connections develop and are sustained should be a priority for longitudinal researchers.

We are cautious about making policy implications. We are well aware that even though this is a longitudinal study with all of its advantages, it is an observational study and the findings need to be replicated in other studies with other populations. However, if the findings do replicate, experimental studies might be designed that would investigate the possibilities of creating social conditions that would enhance the formation of social connections. Neighbourhood opportunities might be enhanced, particularly in disadvantaged neighbourhoods. Elementary and upper level schools might create more choices for children and adolescents to participate in activities. Early prevention programmes that have targeted aggressive behaviour in young children (Bierman *et al*, 2004; Kellam *et al*, 2008) may examine the outcomes of social connections as well as the outcomes of drug use, violence, and other negative outcomes.

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Long-term trends in BMI: are contemporary childhood BMI growth references appropriate when looking at historical datasets?

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Abstract

Background

Body mass index (BMI) is the most widely used surrogate measure of adiposity, and BMI z-scores are often calculated when comparing childhood BMI between populations and population sub-groups. Several growth references are currently used as the basis for calculation of such z-scores, for both contemporary cohorts as well as cohorts born decades ago. Due to the widely acknowledged increases in childhood obesity over recent years it is generally assumed that older birth cohorts would have lower BMIs relative to the current standards. However, this reasonable assumption has not been formally tested.

Methods

Two growth references (1990 UK and 2000 CDC) are used to calculate BMI z-scores in three historical British national birth cohorts (National Survey of Health and Development (1946), National Child Development Study (1958) and British Cohort Study (1970)). BMI z-scores are obtained for each child at each follow-up age using the LMS method, and their distributions examined.

Results

Across all three cohorts, median BMI z-score at each follow-up age is observed to be positive in early childhood. This is contrary to what might have been expected given the assumed temporal increase in childhood BMI. However, z-scores then decrease and become negative during adolescence, before increasing once more.

Conclusions

The differences in BMI distribution between the historical cohorts and the contemporary growth references appear systematic and similar across the cohorts. This might be explained by contemporary reference data describing a faster tempo of weight increase relative to height than observed in older birth cohorts. Comparisons using externally defined z-scores over extended periods of time should therefore be interpreted with caution.

Keywords

Childhood obesity, body mass index, z-scores, growth references, cohort studies

Introduction

Body mass index (BMI), calculated as an individual's mass (in kilograms) divided by their height (in metres) squared, has become the most widely used surrogate measure of adiposity. Although BMI has shortcomings, not least the inability to differentiate between lean mass and fat mass (Wells, 2001), it is widely used in pediatrics owing to the ease with which measurements can be made on infants and children, and the often routine manner in which serial anthropometric measurements are recorded.

The use of BMI to investigate adiposity in children is complicated further by the manner in which BMI shows profound changes from birth through to early adulthood (Prentice, 1998), with relationships between the fat and fat-free components of the body being affected by varying growth rates and maturity levels (Maynard et al, 2001).

Z-scores (or standard deviation scores) express measurements in terms of standard deviations from the centre of a distribution and are often used with anthropometric measures, facilitating comparisons across ages in otherwise age-dependent variables.

There exist contemporary BMI growth references, notably the 1990 reference curves for the UK ('1990 UK') and the 2000 Centers for Disease Control and Prevention (CDC) growth charts for the United States ('2000 CDC'), which are frequently used to standardise BMI values. Standardisation of a measurement using an external reference dataset allows an assessment of the position of the measurement within the reference distribution. However, it is unclear whether these growth references are useful as comparisons to less contemporary data. Specifically, given the widely acknowledged increases in childhood BMI over recent years (World Health Organisation, 2000), it may be expected that, on average, childhood BMI in historical datasets would be lower than in the contemporary growth references, leading to a preponderance of negative BMI z-scores. If standardisation does lead to z-scores which do not follow a standard normal distribution, then there may be implications for interpretation of any analysis using these standardised values. For example, if the distribution of BMI z-scores has a mean of -0.5 then an individual with a z-score of 0, who would normally be considered as having average BMI, would in fact have above average BMI when compared to his or her peers within the same dataset. In this situation it would be important to emphasise that the z-scores are relative to a given standard rather than relative to other subjects within the same dataset, and this may not always be what is wanted.

The aim of the present analysis is to assess the validity of using contemporary BMI growth references when looking at historical British datasets. This is achieved by the calculation and analysis of BMI z-scores using both the 1990 UK and 2000 CDC growth references for three different British national birth cohorts. These cohorts (National Survey of Health and Development (NSHD), National Child Development Study (NCDS) and British Cohort Study (BCS)) are chosen for their national representativeness, range of years of birth (1946-1970), range of ages for which BMI data are available (4-16 years) and longitudinal nature, meaning that the same children can be examined at several follow-up ages in each cohort.

As all three cohorts are made up of children resident in the UK, the 1990 UK growth references would be the more appropriate choice for standardisation of the data. However, as the 2000 CDC growth references would also often be used, their application remains of great interest.

Materials and methods

Study samples

The National Survey of Health and Development (NSHD) is one of the longest running large-scale studies of human development in the world (Medical Research Council NSHD team, 2008). It began as an investigation into the social and economic aspects of 13,687 births occurring during the first week of March 1946 in England, Scotland and Wales. From this original population, a sample consisting of all children whose fathers were non-manual or agricultural workers and a randomly selected one in four sample of children of other manual workers (5362 subjects in total) have been followed up at regular intervals since birth, with children being measured and weighed in underclothes as part of their medical examination (Peckham et al, 1983). A more detailed cohort profile can be found elsewhere (Wadsworth et al, 2006). The present analysis includes follow-up at ages 4, 6, 7, 11 and 15 years. Electronic data for the NSHD were obtained directly from the Medical Research Council NSHD team at University College London.

The National Child Development Study (NCDS) takes as its subjects all the people born in England, Scotland and Wales in one week in March 1958. It has its origins in the Perinatal Mortality Survey, which initially included 17,416 babies (Centre for Longitudinal Studies, 2008a). The cohort was followed up at several ages throughout childhood, with children being measured and weighed in underclothes as part of their medical examination (Peckham et al, 1983). A more detailed cohort profile can be found elsewhere (Power and Elliott, 2006). The present analysis includes follow-up at ages 7, 11 and 16 years. Electronic data for the NCDS were obtained from the UK Data Archive (2007a) and relevant variables identified with the help of the data dictionary provided by the Centre for Longitudinal Studies (2005a).

The British Cohort Study (BCS) takes as its subjects all those living in England, Scotland and Wales who were born in one week in April 1970. Data were collected about the births and families of 16,571 babies, and since then there have been several attempts to gather information from the whole cohort (Centre for Longitudinal Studies, 2008b). Additional people born in the same week, who immigrated to the UK or were identified subsequently, have been added to the cohort. Height and weight at follow-up were measured by school medical staff with a standardised technique (Viner and Cole, 2005). A more detailed cohort profile can be found elsewhere (Elliott and Shepherd, 2006). The present analysis includes measurements at ages 10 and 16 years. Weight was not measured at age 5 years so this follow-up age cannot be included. Electronic data for the BCS were obtained from the UK Data Archive (2007b) and relevant variables identified with the help of the data dictionary provided by the Centre for Longitudinal Studies (2005b).

BMI growth references

BMI reference curves for UK children were developed for the first time in the mid-1990s (Cole, Freeman and Preece, 1995) based on data collected between 1978 and 1990. Data from 11 distinct surveys were combined, between them recording BMI from birth to age 23, with most being representative of England, Scotland and Wales and all but one being cross-sectional. Summary centile curves were fitted using the LMS method and penalised likelihood (Cole and Green, 1992).

The 2000 CDC growth charts for the United States represent a revised version of the 1977 National Center for Health Statistics (NCHS) growth charts and include BMI-for-age charts (CDC, 2007a). Most of the data came from the National Health and Nutrition Examination Survey (NHANES) cross-sectional studies conducted from 1963 to 1994, though some supplementary data sources were also utilised. Initial curve smoothing for selected major percentiles was accomplished with various parametric and nonparametric procedures, then a normalisation procedure was used to generate z-scores that closely match the smoothed percentile curves (Kuczmarski et al, 2000).

Statistical analysis

For every child at each follow-up age in all three cohorts BMI z-scores are calculated using both the 1990 UK and 2000 CDC growth references. For a BMI z-score to be calculated for a given child, and thus for the child to be included in the analysis, data for age, sex and BMI are required. Although each follow-up in each cohort was planned at a specific age, the actual measurements occur over a range of ages. Whilst some variation in age at measurement is unavoidable, it is likely that those at the extremes of the age distribution form a distinct subgroup. For example, subjects measured more than a year after the median age may have been hospitalised for a long period, so their inclusion would undermine the homogeneity of the sample. Thus a further stipulation imposed for these analyses is that all children included at a given follow-up age must have had their measurement within 6 months of the median age at measurement within that follow-up age group. This additionally ensures that when we discuss subjects at a given follow-up age we are referring only to measurements over a 1 year period rather than over a 2-3 year period, which could cause overlap between the follow-up ages.

The calculation of BMI z-scores using the 1990 UK and 2000 CDC growth references uses the LMS method (Cole and Green, 1992). The LMS method summarises the changes in BMI distribution through childhood in a reference dataset by three curves representing the median (M), coefficient of variation (S) and a measure of skewness (L) based on the Box-Cox power required to transform the data to normality. The three parameters are constrained to change smoothly with age, and are estimated using penalised maximum likelihood. Once the L, M and S parameters are defined for a reference dataset they can then be used to calculate the BMI value corresponding to any given percentile or z-score, enabling the construction of growth charts. Conversely, given a BMI measurement, the L, M and S parameters can be used to calculate where, in terms of percentile or z-score, said measurement would occur relative to the distribution of the reference dataset.

The 1990 UK BMI-for-age LMS parameters are extracted from the Microsoft Excel add-in *lmsGrowth* (Cole and Pan, 2005), with equivalent parameters for the 2000 CDC growth reference obtained via the CDC website (CDC, 2007b).

The z-score (z) for a given BMI measurement (X) is calculated as

$$z = \frac{(X/M)^L - 1}{LS} \text{ if } L \neq 0$$

or

$$z = \frac{\log(X/M)}{S} \text{ if } L = 0,$$

where L, M and S are the growth reference LMS parameters corresponding to the age and sex of the child.

If the BMI values for a study population agree closely with the growth reference, then the z-scores calculated should be normally distributed with mean 0 and standard deviation 1. Once calculated, BMI z-scores in each cohort may then be assessed at each follow-up age for any systematic deviation from this (i.e. any systematic difference from the growth reference).

BMI measurements are deemed implausible if they correspond to an absolute z-score (using the 1990 UK growth reference) greater than six and are thus excluded, as has been practiced elsewhere (Tate, Dezateux and Cole, 2006).

We additionally explore whether the observed BMI z-scores in each cohort could be explained by a faster developmental tempo in the (generally) more contemporary BMI references. To do this we construct an artificial dataset by taking the 1990 UK growth reference median BMI values and stretching the timescale using a multiplicative shift of 1.2. We introduce an additional component allowing this slowing down of the developmental tempo to fade away over time, so that by age 18 years the timescale would be back to its original value. As this manipulation results in the lowest point of the BMI curve (the 'BMI rebound') occurring later relative to 1990 UK median, this artificial dataset is referred to as

the 'delayed BMI rebound cohort'. BMI z-scores for the delayed BMI rebound cohort are calculated using the 1990 UK reference data and the method described above and compared to the BMI z-scores observed in the birth cohorts.

Results

Table 1 shows the numbers and percentages of subjects included in and excluded from the analysis at each follow-up age. The 'target sample' in each instance is the maximum possible number of individuals for whom data could potentially be collected after the exclusion of the dead, those living abroad and permanent refusals. 'Achieved sample' is the number of individuals for whom at least one response was recorded. 'Sex, age or BMI missing' for an individual means that their BMI z-score cannot be calculated, so they are excluded from the analysis. 'Age > 6 months from follow-up median' for an individual means that the age at which their BMI was observed is not sufficiently similar to the other ages within the age group to allow their inclusion in the analysis.

In the NSHD the achieved sample at each follow-up age was between 89 and 96% of the target sample. The NCDS includes similarly high levels of achieved sample at each follow-up age, though a greater degree of missing sex, age or BMI data, particularly at age 16 years (25%). Whilst the proportion of the target sample achieved in the BCS was of a similar magnitude to the other cohorts at follow-up age 10 years, at age 16 years the data collection was noticeably reduced by a teachers' strike (Elliott and Shepherd, 2006). Additionally, over 50% of children have either sex, age or BMI values missing so cannot be included in the analysis, meaning that at age 16 years the BCS cannot be considered as nationally representative as the other cohorts.

From Table 1 it can be seen that the requirement for data to have been recorded within 6 months of the median age at each follow-up age rarely results in the exclusion of a significant amount of data and never more than 4% of the achieved sample.

The percentage of males and summaries of the age and BMI distributions for the subjects who are included in the analysis are shown in Table 2. In each cohort at each follow-up age, except the less-representative age 16 years follow-up in the BCS, there are slightly more males than females. Due to the skewed nature of the age and BMI distributions, medians and inter-quartile ranges (IQRs) are presented. Both the magnitude and the variability of BMI can be seen to increase after about age 7 years.

It is possible to calculate the years of birth of the children included in the reference datasets by examining the data collection dates and subject ages (Cole, Freeman and Preece, 1995; Kuczmarski et al, 2000). These are presented in Table 3 for each age considered. Across all the ages, UK 1990 reference data were collected from subjects born 1962-84 and CDC 2000 reference data were collected from subjects born 1950-90. Thus, whilst all the data for both BMI references were collected from subjects born after those in the NSHD (in many case quite considerably after), for the other birth cohorts this is not always the case. At ages 11 and 16 years some of the subjects in the CDC 2000 reference dataset were born a little earlier than the NCDS subjects. Nearly all the subjects in the UK 1990 reference dataset were born after the BCS subjects at age 10 years, but almost all the CDC 2000 children were born before. At age 16 years all or virtually all the subjects in both BMI references were born before the BCS subjects.

Table 1. Numbers and percentages of subjects included in/excluded from the analysis by birth cohort and follow-up age. NSHD is the National Survey of Health and Development, NCDS is the National Child Development Study and BCS is the British Cohort Study. ^AInformation taken from Wadsworth et al (2003a) (NSHD), Power and Elliott (2006) (NCDS) and Elliott and Shepherd (2006) (BCS). ^BPercentage of target sample at follow-up. ^CPercentage of achieved sample at follow-up.

Cohort	Year of birth	Initial cohort size ^A	Follow-up age (years)	Target sample at follow-up ^A	Achieved sample at follow-up ^A (% ^B)	Excluded from analysis			Included in analysis (% ^C)
						Sex, age or BMI missing (% ^C)	Age > 6 months from follow-up median (% ^C)		
NSHD			4	4900	4700 (95.9%)	520 (11.1%)	23 (0.5%)	4157 (88.4%)	
			6	4858	4603 (94.8%)	758 (16.5%)	13 (0.3%)	3832 (83.0%)	
	1946	5362	7	4838	4480 (92.6%)	542 (12.1%)	5 (0.1%)	3933 (87.8%)	
			11	4799	4281 (89.2%)	402 (9.4%)	9 (0.2%)	3870 (90.4%)	
			15	4790	4274 (89.2%)	698 (16.3%)	10 (0.2%)	3566 (83.4%)	
NCDS			7	16727	15425 (92.2%)	2168 (14.1%)	589 (3.8%)	12 668 (82.1%)	
	1958	17416	11	16754	15337 (91.5%)	2848 (18.6%)	0 (0.0%)	12489 (81.4%)	
			16	16901	14647 (86.7%)	3609 (24.8%)	299 (2.0%)	10739 (73.3%)	
BCS			10	17275	14874 (84.9%)	2901 (19.5%)	419 (2.8%)	11554 (77.7%)	
	1970	16571	16	17529	11621 (66.3%)	5905 (50.8%)	262 (2.3%)	5454 (46.9%)	

Table 2. Distributions of key variables for subjects included in the analysis by sex. NSHD is the National Survey of Health and Development (1946 cohort), NCDS is the National Child Development Study (1958 cohort), BCS is the British Cohort Study (1970 cohort). BMI is body mass index and IQR is inter-quartile range.

Cohort	n	Follow-up age (years)	% male	Age (years)				BMI (kg/m ²)							
				Min.	Median	Max.	IQR	Males			Females				
								Min.	Median	Max.	IQR	Min.	Median	Max.	IQR
NSHD	4157	4	52.5	4.2	4.3	4.8	0.0	11.2	16.2	22.9	1.9	10.7	15.9	22.6	2.2
	3832	6	52.7	5.9	6.0	6.5	0.1	11.8	15.9	22.6	1.7	11.9	15.6	23.2	1.7
	3933	7	51.8	6.9	7.0	7.5	0.1	11.0	15.8	24.8	1.7	11.8	15.5	26.2	1.8
	3870	11	52.0	10.7	10.8	11.3	0.1	12.5	16.9	29.8	2.3	11.4	17.0	32.9	2.9
NCDS	3566	15	52.5	14.3	14.5	15.0	0.3	13.0	19.3	33.8	2.8	12.1	20.3	39.8	3.5
	12668	7	51.7	7.1	7.3	7.8	0.2	10.7	15.8	29.0	1.7	10.0	15.6	28.2	2.0
	12489	11	51.1	10.9	11.4	11.8	0.1	11.7	16.8	32.9	2.4	10.9	17.1	37.7	3.1
BCS	10739	16	51.7	15.4	15.8	16.3	0.2	13.0	19.8	43.9	2.9	12.5	20.6	41.1	3.5
	11554	10	51.6	10.1	10.5	11.0	0.3	10.9	16.4	29.4	2.2	10.2	16.6	30.9	2.8
	5454	16	48.7	16.3	16.7	17.2	0.3	13.0	20.5	67.6	3.4	13.0	21.0	48.1	3.8

The distributions of the calculated BMI z-scores for each birth cohort using the 1990 UK and 2000 CDC growth references are shown in Table 4 and Table 5, respectively. Once more, medians and IQRs are presented due to the skewed nature of the distributions. There is clearly a great deal of variation in the median values of BMI z-score in the cohorts at different follow-up ages. Median z-scores are generally positive in early childhood before decreasing, often becoming negative, then increasing once more. These results are more easily interpretable when plotted graphically.

Table 3. Ranges of years of birth of subjects in each reference dataset for each age considered in the present analysis.

BMI reference	Age (years)	Range of years of birth
UK 1990	4	1983
	6	1972-84
	7	1971-83
	10	1968-80
	11	1967-79
	15	1963-71
	16	1962-71
CDC 2000	4	1967-90
	6	1957-88
	7	1956-73
	10	1953-70
	11	1952-69
	15	1951-65
	16	1950-64

Table 4. Distributions of calculated body mass index (BMI) z-scores using the 1990 United Kingdom (UK) growth reference, by sex. NSHD is the National Survey of Health and Development (1946 cohort), NCDS is the National Child Development Study (1958 cohort) and BCS is the British Cohort Study (1970 cohort). Results weighted to adjust for the one in four sampling of children from manual and self-employed workers.

Cohort	Follow-up age (years)	BMI z-score							
		Males				Females			
		Min.	Median	Max.	IQR	Min.	Median	Max.	IQR
NSHD	4	-5.59	0.41	3.85	1.45	-5.44	0.21	3.40	1.41
	6	-4.14	0.29	3.23	1.29	-3.07	0.08	3.14	1.06
	7	-5.33	0.16	3.44	1.17	-3.13	-0.07	3.32	1.10
	11	-3.55	0.02	3.16	1.13	-4.43	-0.19	3.37	1.35
	15	-4.70	0.08	3.15	1.20	-5.30	0.23	3.63	1.30
NCDS	7	-5.85	0.14	4.09	1.15	-5.57	-0.08	3.65	1.18
	11	-4.88	-0.14	3.37	1.29	-5.28	-0.28	3.73	1.45
	16	-5.15	0.01	3.84	1.24	-5.10	0.08	3.69	1.28
BCS	10	-5.75	-0.16	3.17	1.19	-5.97	-0.27	3.18	1.35
	16	-5.50	0.03	4.66	1.37	-4.89	0.09	4.15	1.37

Table 5. Distributions of calculated body mass index (BMI) z-scores using the 2000 Centers for Disease Control and Prevention (CDC) growth reference, by sex. NSHD is the National Survey of Health and Development (1946 cohort), NCDS is the National Child Development Study (1958 cohort) and BCS is the British Cohort Study (1970 cohort). Results weighted to adjust for the one in four sampling of children from manual and self-employed workers.

Cohort	Follow-up age (years)	BMI z-score							
		Males				Females			
		Min.	Median	Max.	IQR	Min.	Median	Max.	IQR
NSHD	4	-6.46	0.53	3.70	1.49	-8.35	0.50	2.84	1.38
	6	-5.07	0.36	2.50	1.23	-3.89	0.25	2.46	1.05
	7	-7.04	0.18	2.52	1.11	-3.83	0.06	2.49	1.10
	11	-3.90	-0.12	2.33	1.05	-4.68	-0.17	2.48	1.22
	15	-5.03	-0.13	2.37	1.10	-5.54	0.21	2.49	1.08
NCDS	7	-7.90	0.15	2.79	1.10	-8.05	0.04	2.64	1.17
	11	-5.42	-0.29	2.46	1.20	-5.61	-0.24	2.66	1.30
	16	-5.51	-0.21	2.87	1.15	-5.47	0.08	2.47	1.08
BCS	10	-6.75	-0.28	2.33	1.13	-6.73	-0.24	2.38	1.24
	16	-5.98	-0.23	3.43	1.27	-5.45	0.06	2.59	1.16

Fig. 1 and Fig. 2 show the median BMI z-score plotted against the median age at each follow-up age in the three cohorts. Fig. 1 displays the BMI z-scores calculated using the 1990 UK (upper plot) and 2000 CDC (lower plot) growth references for males, and Fig. 2 shows the equivalent plots for females. Whilst the four plots show all three cohorts to exhibit broadly similar patterns of BMI z-score throughout childhood, there are some cohort-, sex- and growth reference-specific features.

For the males of all three cohorts, using the 1990 UK growth reference (Fig. 1, upper plot) results in a median BMI z-score that is positive but decreasing through early childhood, reaching a minimum around age 11 years before increasing once more. In the NSHD (the earliest birth cohort) this minimum value corresponds to a BMI z-score of approximately zero, whereas in the other cohorts the minima are clearly negative. Use of the 2000 CDC growth references (Fig. 1, lower plot) results in a similar pattern of median BMI z-score through early childhood. In this case, however, all three cohorts cross into negativity, with more extreme minimum values exhibited, then, rather than returning to positivity, they merely level off and remain negative.

Over the age range for which data are available for more than one cohort a cross-cohort comparison can be made. It can be seen that at age 6-7 years the median BMI z-scores for the NSHD and NCDS are very similar whereas at later ages it is the NCDS and the BCS that take similar values with those for the NSHD clearly greater, especially around age 11 years.

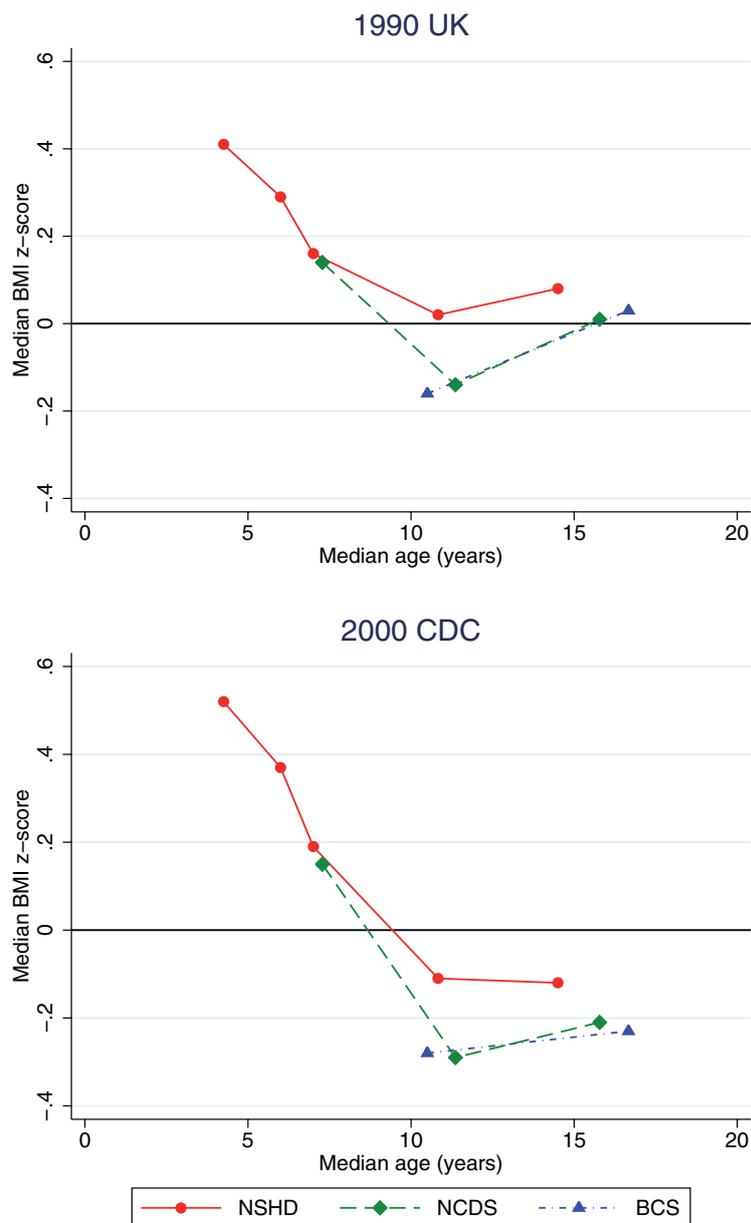


Figure 1. Plots of body mass index (BMI) z-score calculated using the 2000 Centers for Disease Control and Prevention (CDC) (upper plot) and 1990 United Kingdom (UK) (lower plot) growth references against age for males. NSHD is the National Survey of Health and Development (1946 cohort), NCDS is the National Child Development Study (1958 cohort) and BCS is the British Cohort Study (1970 cohort).

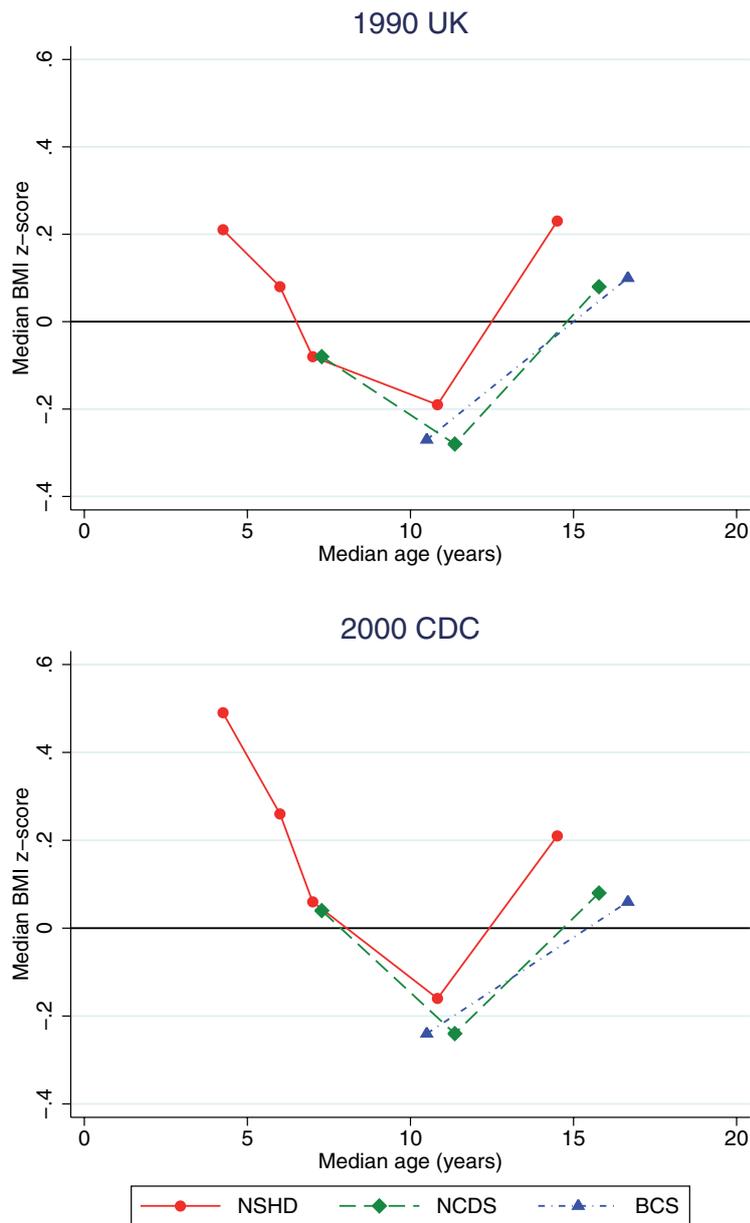


Figure 2. Plots of body mass index (BMI) z-score calculated using the 2000 Centers for Disease Control and Prevention (CDC) reference (upper plot) and 1990 United Kingdom (UK) (lower plot) growth references against age for females. NSHD is the National Survey of Health and Development (1946 cohort), NCDS is the National Child Development Study (1958 cohort) and BCS is the British Cohort Study (1970 cohort).

Median BMI z-scores at each follow-up age in females are plotted in Fig. 2. Under both growth references the median BMI z-score is positive though decreasing through early childhood, before crossing into negativity, with all three cohorts reaching a minimum of about -0.2 around age 11 years. Median BMI z-scores then increase once more to exhibit positive values in adolescence. The main difference between the two plots in Fig. 2 is that when using the 2000 CDC growth reference the median BMI z-score is noticeably greater through early childhood, resulting in it becoming negative slightly later, though generally the growth reference-specific differences are less marked than in the males.

In terms of the differences between the cohorts within each plot, the pattern is somewhat similar to that seen for the males, with median BMI z-score in the NSHD and the NCDS similar at age 6-7 years, then median BMI z-score in the NSHD becoming increasingly greater than in the other two cohorts at older ages.

Whilst the overall trends in median BMI z-score profile are clearly similar under the two growth references, there are some differences. The 2000 CDC reference data appear to decrease the z-score value relative to the 1990 UK data somewhat in males at follow-up ages of 10 years and older, whereas females of follow-up age 7 years and younger see an increased BMI z-score. These observations correspond to the differences between the growth references evident in Fig. 3, showing median BMI in each growth reference plotted against age, for males (upper plot) and females (lower plot). The upper plot shows that up to approximately age 8 years, the two medians for the males are very similar, but then the 2000 CDC median becomes noticeably and increasingly greater than the 1990 UK median. This means that males of this age would have a reduced BMI z-score if calculated with the 2000 CDC reference data. However, in females (lower plot), it is between the ages of approximately 3 and 10 years that there is a difference between the two reference medians, with the 2000 CDC median being the lower in this instance. This results in any BMI z-scores calculated over this age range being greater when using the 2000 CDC reference data.

In order to explore whether the observed BMI z-scores in each cohort could be explained by a faster developmental tempo in the (generally) more contemporary BMI references, we construct an artificial cohort with a reduced developmental tempo (the 'delayed BMI rebound cohort') as described in the Methods section. The upper plot in Fig. 4 is of BMI against age for the 1990 UK growth reference median and the median of the delayed BMI rebound cohort. It can be seen that the median age at which the BMI rebound occurs has been delayed from 5.9 years in the 1990 UK growth reference to 6.7 years. BMI z-scores for the artificially constructed cohort (calculated using the 1990 UK reference) are presented in the lower part of Fig. 4, plotted against age. The similarity between this plot and many of the equivalent plots for the cohorts included in this analysis is apparent.

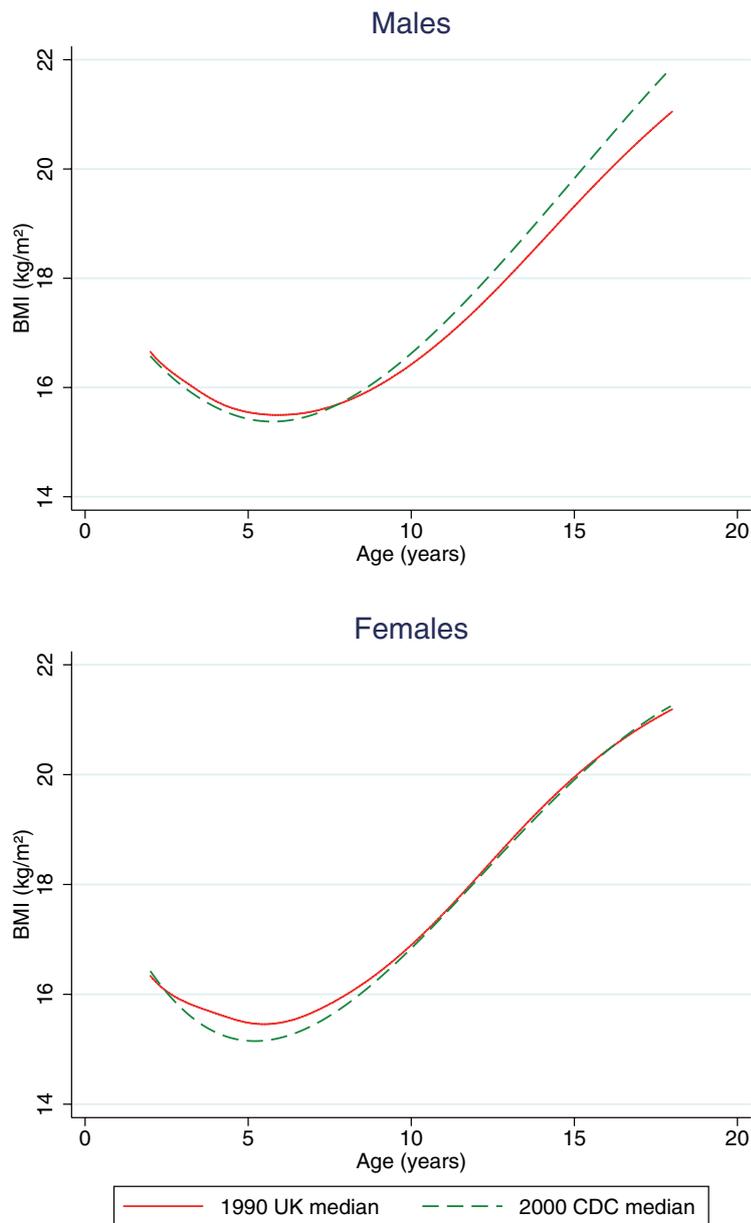


Figure 3. Plots of median body mass index (BMI) in the 1990 United Kingdom (UK) and 2000 Centers for Disease Control and Prevention (CDC) growth references against age for males (upper plot) and females (lower plot).

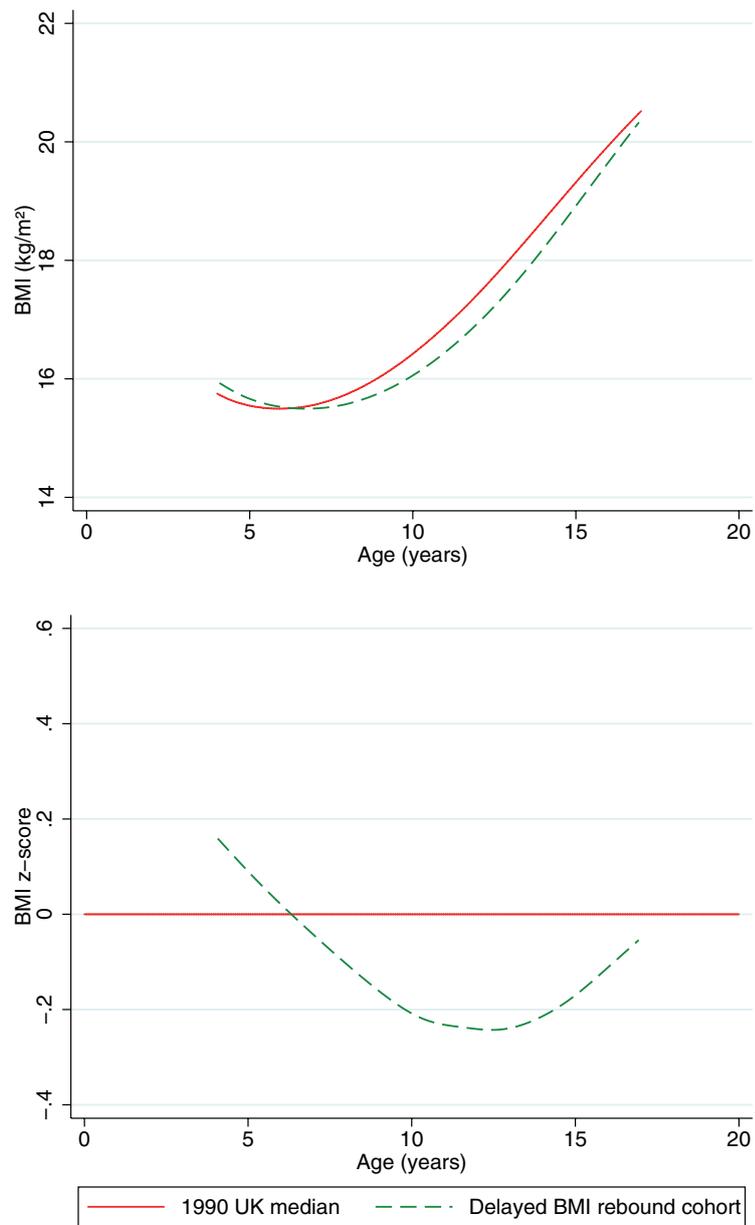


Figure 4. Plots of body mass index (BMI) (upper plot) and body mass index z-score calculated using the 1990 United Kingdom (UK) growth reference (lower plot) against age for the artificially constructed delayed BMI rebound cohort.

Discussion

This analysis has uncovered a tendency for historical cohorts of children born between 1946 and 1970 to differ in terms of BMI distribution from both the 1990 UK and 2000 CDC growth references. Moreover, the deviations exhibited are systematic and largely similar between the historical cohorts. All three cohorts have positive but decreasing BMI z-score through early childhood. There is a general trend for z-scores to become negative in the pre-pubertal period, attaining a minimum value in early puberty, before beginning to increase once more, most markedly in females, in the late-pubertal period.

The proportion of subjects included in the analysis at each follow-up age in each cohort is always somewhat less than 100%. Whilst this could lead to the analysed subjects not being nationally representative, the fact that the changes in BMI z-score with increasing age are not in a consistent direction suggests that they are not merely a result of selective missingness. We thus believe that the patterns in BMI z-score observed are genuine.

Given the widely acknowledged obesity 'epidemic' evident over recent years (World Health Organisation, 2000), it may be expected that the calculation of z-scores in historical cohorts using more contemporary reference data would lead to negative values in the majority of subjects. All the NSHD subjects, and those at the younger follow-up ages in the NCDS, were born before both sets of reference subjects in the present analysis, but consistently negative BMI z-scores are not observed. Similarly, as the BCS subjects were born around the same time or later than the reference subjects, one may anticipate their BMI z-scores to consistently lie close to zero or even be positive. However, their BMI z-scores are clearly negative at age 10 years for both sexes and both BMI references, remaining so at age 16 years for males using the 2000 CDC reference.

It may also be expected that the historical cohorts show a temporal ordering, with those born more recently having relatively higher BMI z-scores. In addition to its less temporal proximity, one may additionally expect childhood BMI in the NSHD to be lower than in the other cohorts due to cohort members' nutrition being influenced by food rationing, which continued after the war until 1954 (Hollingsworth, 1961). Although the cross-cohort comparisons are limited by the short range of ages for which data are available for all the cohorts, it is clear that no such temporal ordering exists. Indeed, BMI z-score in the NSHD is almost always higher than that seen in the other cohorts. Previous analyses have found BMI to be similar between NSHD and NCDS at age 7 years (Li et al, 2008) and at age 11 years (Wadsworth et al, 2003b), which is in agreement with our observations. It has also been suggested that BCS subjects have considerably larger BMI at age 10-11 years than subjects in the other two cohorts (Wadsworth et al, 2003b), but we do not find this in the present analysis.

To expect patterns in BMI z-score through childhood in the historical cohorts predating the reference datasets to be merely 'negative' may be something of an over-simplification. For the median BMI z-score in a given cohort to take a constant value of, say, -0.2 across the entire range of ages would mean the median BMI within the cohort being equal to the median BMI in the reference dataset minus 0.2 of a standard deviation at each follow-up age. Implicit in this is that the median BMI growth trajectories in the historical cohort and the reference dataset follow the same shape. However, acknowledged secular changes in growth patterns over the last century, particularly a trend towards a faster developmental tempo (Cole, 2003), mean this may not be true.

One way to describe the BMI growth trajectory is by the timing of the BMI rebound, with a secular increase in developmental tempo being evidenced by an advancing BMI rebound. Indeed, precisely this trend has been found in Swedish children between 1973-5 and 1985-7 (Eriksson, Rasmussen and Nordqvist, 2005). Through the construction and analysis of a delayed BMI rebound cohort, we have shown that the results observed in the present analysis could plausibly be explained by more rapid development in the reference data relative to that seen in the historical cohorts.

An earlier BMI rebound has been shown to be associated with increased BMI in adolescence and adulthood (Rolland-Cachera et al, 1984; Rolland-Cachera et al, 1987). Although the growth references and historical cohorts examined here are not truly

comparable in the same way as, say, two individuals in the same cohort, it is conceivable that a similar mechanism could be at work, with the earlier BMI rebound of the reference data leading to increased BMI at a later date. In this way, the positive z-scores evident in early childhood could be attributed solely to the earlier BMI rebound in the reference data, with the possibility of greater BMI in adulthood in the more contemporary reference dataset bringing the findings more in line with recent trends. This does, however, conflict somewhat with the positive z-scores around age 15 years, particularly in the NSHD, which remain more difficult to explain.

It is also informative to consider the observed patterns of BMI z-scores in the historical cohorts in terms of the corresponding height and weight z-scores. Calculation of these z-scores using an analogous method to that for BMI shows that both are almost always negative, though height z-scores are generally more negative than weight z-scores. In particular, the ages at which positive BMI z-scores are observed correspond to periods where weight z-scores are close to zero and height z-scores are more strongly negative, meaning subjects in the historical cohorts have slightly lower weight than those in the reference samples, but are much shorter.

The observed trends could certainly affect analyses which use z-scores calculated using the UK 1990 or CDC 2000 BMI references. Take, for example, a female in the NSHD with a BMI of 15.5 kg/m² at age 4 years, 17.8 kg/m² at age 11 years and 19.1 kg/m² at age 15 years. These BMI values correspond respectively to the 38th, 64th and 32nd centiles of the observed BMI values in the NSHD at each follow-up age. Standardised using the CDC 2000 BMI reference, all three measurements correspond to a z-score of +0.2. This subject would thus be considered as maintaining the same relative BMI throughout childhood. However, when compared to her own peers within the NSHD this is clearly not quite the case. If females following a similar BMI trajectory to this were found to, say, be at increased risk of a certain adverse health outcome, then it is possible that using the z-scores rather than the observed BMI values themselves may lead to a slightly different interpretation.

If BMI z-scores are being used in an analysis as a means of comparing the observed BMI measurements to those in the reference dataset, then external standardisation using that reference dataset is a valid approach. If z-scores are merely required to rescale BMI, however, then standardisation using an external reference dataset may provide misleading results, as seen above. One potential alternative is to use internal standardisation, where the z-score for a subject is calculated based on the position of their measurement relative to those of their peers within the same dataset. This could be achieved using the LMS method (Cole and Green, 1992) to effectively construct a growth chart based on the observed data. For a sufficiently large dataset this approach will provide normally distributed z-scores with mean zero, though it is not recommended for very small datasets. In these instances, external standardisation may remain the only viable option.

To conclude, if children in historical datasets and children in growth references do not have similar distributions of measurements at a given age, then the resultant z-scores will not follow the expected standard normal distribution. When comparisons are to be made across ages, and the differences between the distributions of measurements in the historical and reference datasets are not broadly consistent at each age, for example due to different underlying growth trajectories, then analyses may potentially be misleading. Unless any differences in the age-specific distributions are explored and acknowledged, for example by reporting details of the distribution of the calculated z-scores, externally defined z-scores should be viewed with caution.

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Family Socialization, Economic Self-Efficacy, and the Attainment of Financial Independence in Early Adulthood

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Abstract

The attainment of financial independence is a key marker of the contemporary transition to adulthood. In this study we ask, how do young adults gain the capacity to support themselves? We contend that communication about work in the family during adolescence is an important precursor of economic self-efficacy during adolescence, which is positively associated with financial independence in early adulthood. Drawing upon rich longitudinal data that span adolescence and young adulthood, we first ask whether family communication and socialization practices surrounding work and finances influence the development of ways of thinking about oneself that imply self-reliance and confidence in the economic domain (economic self-efficacy). Second, we assess whether economic self-efficacy, measured during adolescence, has a long-term influence on the transition to adulthood, status attainment, and financial independence. Our findings indicate that direct communications about work with parents foster the development of economic self-efficacy. This positive dimension of the self-concept fosters achievement during the transition to adulthood (e.g., educational achievement, employment status, and income attainment), which, in turn, heighten financial independence in early adulthood.

Keywords

Economic socialization; attainment; family

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Introduction

The attainment of financial independence is a critical component of the contemporary transition to adulthood. Financial independence is closely linked to major demographic markers of this transition. The start of a career, usually following the completion of formal schooling, fosters economic independence, which, in turn, can provide the financial wherewithal for other markers of adulthood, such as residing outside the parental home, marriage and parenthood. In addition, difficulties in becoming financially independent can precipitate a return to the family of origin after becoming residentially independent (Goldscheider and Goldscheider, 1994); such problems may also lead to welfare dependency. Along with its linkage to these demographic markers of adulthood, financial independence has considerable psychological salience to young people themselves. When asked to consider what is necessary to become an adult (Arnett, 1994, 1998), young adults point to financial independence as a central consideration. In addition, Furstenburg et al (2004) report that among respondents to the 2002 U. S. General Social Survey, 97% said that financial independence is at least somewhat important to being considered an adult. Surprisingly, despite the importance of financial independence in the transition to adulthood, little research has been conducted on the factors that foster the attainment of this desired state.

In this paper, we contend that economic self-efficacy is a key precursor of economic independence in early adulthood. In addition, we suggest that socialization processes that occur within the family during adolescence might influence economic self-efficacy. The present research builds on a wide-ranging body of prior work in the status attainment tradition and in social psychology by examining a rich longitudinal data set for plausible familial and psychological precursors of financial independence in early adulthood. Specifically, we investigate the role of family communication and socialization, operationalized by hearing parents talk about work, parent-child discussions about work, work arrangements in the home (chores and special work projects for which the child is paid), and the receipt of a regular allowance. Drawing upon panel data that span adolescence and young adulthood, we first ask whether these socialization practices surrounding work and finances influence the development of ways of thinking about oneself that imply self-reliance and confidence in the economic domain (economic self-efficacy). Second, we assess whether economic self-efficacy has a long-term influence on the transition to adulthood and status attainment, thereby affecting financial independence in young adulthood.

Background

Prior Research

Many social science literatures have relevance to educational and occupational achievement, but do not address financial independence directly. A well-developed body of research has examined the antecedents of socioeconomic attainment, as indicated by years of schooling, educational credentials, occupational prestige, and, of greatest interest here, earned income (Sewell and Hauser, 1975; Featherman, 1980). This work highlights family socio-economic background, as well as adolescents' educational and occupational aspirations and plans, as precursors of adult attainments. There is also a long-standing tradition of research on intergenerational transfers of wealth (Kohli, 2003; Keister, 2003). The absence of wealth among minority families seriously reduces the educational prospects and earning potential of their children (Orr, 2003). However, the attainment of socioeconomic status, even income, while clearly linked to financial independence, is not the same; many young people (and adults) with seemingly good jobs and adequate earnings are plagued by overwhelming debt and financial insecurity.

Several institutional features of contemporary American society foster prolonged financial dependency, high levels of young adult indebtedness, and considerable difficulty and anxiety surrounding self-support. Shifts in the economic structure have made the achievement of financial independence particularly challenging for young people. Whereas youth entering the labour market after high school in the mid-twentieth century had access to good blue collar jobs that could support a family (Schneider and Stevenson, 1999), labour market opportunities for young people who do not have specialized training or college degrees have declined precipitously. Indeed, young people (age 18-32) in the U.S. are more likely to have poverty-level incomes than their counterparts in five other industrialized

countries (Smeeding and Phillips, 2002). In addition, rapid technological change, economic turbulence, and organizational instability complicate career decision-making and diminish the likelihood of stable career progressions that yield high earnings and the receipt of health insurance and other benefits. These social and technological changes, and consequent employment restructuring, increase uncertainty and make the transition from school to work more difficult for contemporary cohorts of youth in Britain, Germany, and other post-industrial societies as well as in the United States (Bynner, 1998; Bynner and Parsons, 2002; Heinz, 2003).

These macroeconomic trends give young people strong incentives to pursue postsecondary education to enhance their credentials in an increasingly competitive labour market. The extension of higher education has marked personal benefits for youth (Pallas, 2003), but by prolonging the transition to adulthood (Shanahan, 2000) higher education also lengthens the duration of time that young people are at least partially, and often substantially, financially dependent on their parents. Fifty-three percent of U.S. students entering 4-year colleges in 1995-96 earned a bachelor's degree within five years; 17 percent were still enrolled by 2000-2001 (National Center for Educational Statistics, 2004). The growing cost of higher education, coupled with a reduction in grant programmes, have made it necessary for many young people to accrue large amounts of debt by the time they leave school. With limited financial backing from parents, many college students increasingly look beyond their families for tuition and living expenses, to federal and other loans, supplemented by their own wages from part-time jobs as they attend school (Christie, Munro and Rettig, 2002). Some move in and out of higher degree programmes as their financial circumstances permit. Those who eventually obtain the BA have typically amassed over \$22,000 in loans by the time of graduation. Many recent graduates must set aside more than 8% of their monthly incomes to pay off student loans (King and Bannon, 2002).

As a result of these and other trends, many young people find themselves in difficult financial situations well after they have completed their formal schooling. They typically turn to their parents for help. In fact, analysis of data from the Panel Study of Income Dynamics and the U.S. Census showed that the average financial contribution of parents to children aged 18-34 was \$2,200 annually (Schoeni and Ross, 2004), and many young adults receive support from their parents even when they are employed (Furstenberg et al, 2003).

Under these often trying circumstances, why do some young people move rather smoothly toward financial independence, and others remain dependent on their parents well into their twenties? How do young people gain the capacity to support themselves and how do they acquire confidence in being able to comfortably manage their finances? Given the high psychological salience of financial independence for young adults, as well as its significance for multiple aspects of adult role enactment, it is rather surprising that this phenomenon has received so little systematic scrutiny. Contemporary "economic sociology" is squarely focused on the macro level of analysis, to the neglect of micro-level experiential and social-psychological precursors of financial independence.

Rarely are experiences in the family setting examined as sources of financial independence. One exceptional study (Whittington and Peters, 1996), using longitudinal data from the Panel Study of Income Dynamics, examined the sources of independence, defined jointly by leaving the parental home and by achieving financial self-sufficiency. Parental income was found to be associated with greater dependence up to the age of 18 or 19, after which it predicted greater independence. The authors reason that "higher income parents have greater resources to induce their children to avoid ...behaviours [such as early childbearing and marriage] and to remain dependent on them." Another study by Aquilino (2005) found that family structure had an influential role in parental attitudes towards economic support of their adult children. Parents in intact families (those with both biological parents in the household) were more likely than single parents or step-parents to believe that parents should provide financial support to their children as they transition to adulthood. These studies, however, did not address family communication processes relevant to work and earnings that could foster the achievement of financial independence.

Although parents of higher socioeconomic status present role models to their children signifying economic success, such attainment in itself may be insufficient to instill a sense of economic efficacy and behaviours in children that promote their own financial independence. Parents may be more or less salient role models to their children, depending largely on the closeness of the relationship between parent and child. Consistent with Kohn's "occupational linkage hypothesis" (Kohn, 1981; Kohn and Schooler, 1983), parental work values, linked to parental occupations, are found to affect children's values only under conditions of parental support and communication that facilitate parental

identification (Mortimer, 1976; Mortimer and Kumka, 1982; Mortimer, Lorence and Kumka, 1986; Ryu and Mortimer, 1996). Therefore, the present research focuses on the role of family socialization and communication in the development of economic self-efficacy in adolescence, which could foster adult role transitions and attainments that enable financial independence in young adulthood.

Economic Self-Efficacy

The pervasive consequences of control beliefs for persistence and success in the face of obstacles are well known (Bandura, 1997). Caplan and Schooler (2007) report that self-confidence and non-fatalistic beliefs are linked to a strategy of coping with financial difficulties that is problem-focused (rather than emotion-focused). Self-efficacy in particular is an important determinant of behaviours in many domains. Domain-specific beliefs of efficacy during adolescence may be valuable for later attainments because they promote more effective goal-oriented behaviour. Perceptions of *economic* self-efficacy, once formed, appear to be critical in fostering achievement-relevant behaviours. For example, youth who think they will be successful in achieving their goals, and specifically those in the economic realm, are likely to be more persistent in their preparation and striving for post-secondary education. In fact, the belief that one will be successful in the economic realm is found to enhance academic achievement (grade point average) and educational goals during high school, to increase the likelihood of behaviours conducive to college enrollment (such as seeing counsellors, requesting applications, etc.), and to promote actual post-secondary educational attendance (Grabowski et al, 2001). The higher level of educational attainment thereby promoted could foster financial independence by increasing the likelihood of full-time employment and the stability of earnings in early adulthood. It is likely that high levels of efficacy would also lead to a delay in family formation, to enable postsecondary educational achievement. Thus, youth with higher levels of economic efficacy would likely experience delayed transitions to adulthood, characterized by prolonged school attendance, higher levels of educational and income attainment, and delayed marriage and parenthood.

Bandura (1977) contends that four factors contribute to perceptions of efficacy: personal accomplishments, vicarious experience, verbal persuasion and physiological state. This formulation suggests that beliefs about one's economic self-efficacy are dependent upon the observation of, and persuasion from, others, in addition to one's own achievements and feelings. Little research, however, has examined the influence of the family on the development of this positive self-perception. Grabowski et al (2001) find that family background indirectly influences perceptions of economic self-efficacy through youths' own school and work experiences. In addition, among non-working youth, parents' income was found to be positively related to youths' beliefs about their economic futures. These findings suggest that adolescents may develop a sense of efficacy by observing their parents' achievement. Yet to be examined, however, is whether communication between family members about economic matters influences adolescents' developing sense of confidence in this sphere.

Socialization and Family Communication Processes

We suggest that family socialization, particularly communication about work and money, is an important factor in the development of economic self-efficacy, which leads to a greater likelihood of being financially independent during young adulthood. Baumrind (1980) views socialization as an "adult-initiated process by which developing children, through insight, training, and imitation, acquire the habits and values congruent with adaptation to their culture." Parents and other family members can help socialize youth towards many positive behaviours and attitudes. For example, some researchers have found that teens who communicated often with their parents exhibited less risky sexual behaviours and were less likely to become school age mothers (Fox and Inazu, 1980)¹. Communication in the family has also been shown to be an important factor in informing young people about economic matters. For example, the family is instrumental in teaching children about consumer behaviour and money management (Moschis and Moore, 1979; Moschis, 1985). In addition, Moschis and Moore (1984) find a relationship between family communication about consumption and adolescents' career decisions.

Family communication can occur in various ways, both overtly through social interaction, and covertly through role modeling and reinforcement (positive or negative) of behaviours (Moschis, 1985). To promote the transmission of attitudes and behaviours that foster financial independence, we submit that elements of the parents' work must be brought into the family arena, coming to the child's

awareness and influencing the child's proximal experience. For example, some parents discuss their experiences on the job with one another in the presence of their children, and talk to their children about their work as well. Alternatively, parents may consider their employment as a more separate sphere, with little such discussion or activity penetrating into the family realm (Piotrkowski, 1978). In this study, we examine discussions about work that occur between family members and visits to parents' workplaces.

The division of family work is another experience that may affect economic socialization. Specifically, we assess the time the adolescent spent on regular chores in the home, and consider whether this work is done for pay. On the basis of their research in a rural setting, Elder and Conger (2000) note the potentially positive effects of regular chores, as well as paid work, in producing a sense of competence and importance, in mattering, and in fostering "integration into adult roles and self-conceptions." (91). The assignment of chores can establish a pattern of behaviour premised on the assumption of responsibility for self and others, an everyday experience of working as normal and expected, and a prelude to the similar assumption of economic responsibilities in adulthood. On the other hand, if doing chores promotes orientations and behaviours that enhance dependency and interfere with achievement outside the family, the implications for future financial independence may not be so sanguine.

Finally, we examine whether receipt of a regular allowance fosters economic efficacy and independence. Allowance is widely seen by parents as a form of economic education; through receiving a regular allowance, they believe that children will learn the value of money. Allowance may also be considered a prototypical exchange relation: often teenagers are expected to do their regular chores, get good grades, or display other positive childhood role enactments in order to receive their weekly or monthly stipends. It is therefore plausible that a regular allowance would have a positive influence on economic self-efficacy. However, if allowance is seen as a child's entitlement, it could establish a template of financial dependency that is unlikely to encourage economic independence. (For discussion of the various meanings of allowance, see Miller and Jung, 1990.)

Data and Methods

Data Source

The Youth Development Study (Mortimer 2003) began in 1988 with a randomly-chosen community sample of 1010 ninth graders enrolled in the St. Paul Public School District in Minnesota. United States Census data for 1980 indicate that this site was quite comparable to the nation as a whole with respect to economic and social indicators. The analyses reported here use data from student and parent surveys collected in 1988, when the respondents were freshmen in high school (mostly age 14 and 15), through the ninth wave of the study in 1997, six years after their scheduled graduation from high school, when they were 23 and 24 years old. This dataset is unique in its coverage of family socialization experiences, economic efficacy, transitions marking the onset of adult status, and economic independence. The longitudinal design represents a key asset in our study of the precursors and long-term consequences of economic self-efficacy. Whereas demographic information and other factual data may be measured accurately through retrospective recall, earlier experiences in the family of origin of interest to us here may have little psychological salience to young adults, and thus would be unlikely to be recalled. Any attempt to retrospectively measure adolescent self-efficacy would be quite suspect.

During the first four years of the study, corresponding to the high school period, participants completed questionnaires in their classrooms. If they were not present on either of the two survey administration days scheduled in each school, or if they were not attending school, they completed questionnaires by mail. Extensive tracking and follow-up procedures during each wave of data collection ensured that students who dropped out of school after ninth grade, or moved to another school district, continued to be followed. Data for the post-high school period, from 1992 on, were collected annually (except in 1996) via mailed surveys. Of the original 1010, 788 respondents completed surveys in 1997. The retained sample in recent years is somewhat more advantaged than the initial sample in terms of family socioeconomic background and family composition (favouring the two-parent family), and retention has been more likely for females than males. Still, demographic, attitudinal, and experiential characteristics of the retained sample are quite similar to those of the initial panel (see Mortimer, 2003). Our analyses utilize data from the first, third, fourth, and ninth waves of the study; we select those respondents who

participated in these waves and for whom full information on the variables used in the analysis was available. This yields an analytic sample of 617 respondents. We next describe the variables, which are reported in Table 1.

Table 1. Descriptive Statistics, Youth Development Study, 1988-1997 (N=617).

	mean/ prop.	(s.d.)
Background Variables (Wave 1–9th grade)		
Gender (1=male)	42.30	--
Race (1=white)	83.47	--
Family Income	6.08	(2.32)
Family Composition	72.61	--
Parents' Education		
Less than High School	11.81	--
High School	27.99	--
Some College	39.32	--
College or More	20.87	--
Mother's Employment	87.84	--
Grade Point Average (1=F, 12=A)	7.79	(2.35)
Family Socialization and Communication (Wave 3–11th Grade)		
Hears Parents Discuss Work	3.19	(0.84)
Discusses Work with Parents	3.18	(0.88)
Visits Parents' Workplaces	2.72	(1.98)
Hours per Week on Chores	12.53	(13.84)
Paid Chores (1=yes)	47.81	--
Allowance Receipt (1=yes)	77.15	--
Dependent Variables		
Economic Self-Efficacy (Wave 4–12th Grade)	12.29	(2.31)
Status Attainments (Wave 9–Ages 23-24)		
School Enrollment	55.75	--
Employment Status	84.76	--
Marital Status	20.10	--
Parenthood	29.66	--
High School or Less	31.77	--
Some College	43.27	--
College or More	24.96	--
Income (in thousands)	13.86	(10.08)
Financial Independence (Wave 9–Ages 23-24)	73.72	(34.42)

Key Independent Variables—Family Communication and Socialization towards Work

We measure both covert and overt family communication about work. First, we considered *how often the child hears his/her parents talk about work* ("How often do you hear your parents [stepparents or guardians] talk about their jobs [with each other or with others]?") (1=never, 4=often). Second, we examined *how often the parent talks with the child about his or her work* ("How often does he [she] talk to you about his [her] work?") (1=never, 4=often). The highest value for the two parents was utilized; if

the respondent had only one parent, that measure was used. We also consider *visits to parents' workplaces*, which is comprised of two indicators measuring how often the child visits the parent's workplace (0=never, 6=more than once a week; again, we used the highest value) as a factor in socializing youth towards work.² A unique feature of the Youth Development Study is a battery of questions about parents who do not live with the respondents. As a result, we were able to gain information about parents' work-related communications even for parents who did not live with the youth at the time of the survey. If respondents reported that they had two fathers or two mothers, e.g., a stepfather living with them and a biological father living apart, precedence was given to the parent who was living in the child's household.

As discussed earlier, we also consider other ways that youth can be socialized towards work. *Time spent on chores* was measured by the number of hours spent per week on household chores in the 11th grade, and *paid chores* is a dichotomous variable indicating whether or not the adolescent was paid for doing these chores. A third measure of family socialization towards work is whether or not the youth had ever received an *allowance*.

Dependent Variables

We examine the development of *economic self-efficacy* during high school (measured in 1991 when the respondents were 17-18 years old and in the 12th grade). The young people responded to a series of questions about the future (preceded by a lead-in question, "How do you see your future?"). Specifically, respondents were asked, "What are the chances that: You will have a job that pays well? You will have a job that that you enjoy doing? and You will be able to own your own home?" (Response options ranged from 5=Very high to 1=Very Low). Our measure of economic self-efficacy was created from these three items ($\alpha=.80$). The mean of this composite measure of economic self-efficacy is 12.29, suggesting that the respondents were rather optimistic about their futures. There was little difference between boys and girls in average levels of economic self-efficacy; however, girls tended to be more optimistic about their chances of having a job they enjoy doing in the future.

Next, we examine status attainments and markers of the transition to adulthood as mediating variables in the process of attaining financial independence. Specifically, we examine the impact of *current school enrolment*, *employment status*, *marital status*, *parenthood*, *educational attainment*, and *income* on financial independence, and how they are influenced by family socialization towards work and economic self-efficacy during the adolescent period. In our analysis sample, 56% were enrolled in school in 1997, 85% were employed, 20% were married, and 30% had at least one child. Thirty-two percent of the sample had a high school degree or less, 43% had completed some college, and 25% had obtained a college degree or higher. The average yearly income of employed respondents was about \$16,350 (if respondents were not employed, income was coded as 0; this reduced the average for the entire sample to \$13,860, shown in Table 1).³

Finally, we assess the young adults' *financial independence* by examining the percentage of their living expenses that came from either their own earnings or savings, or from their spouse or partner's earnings and/or savings, at age 23-24. On average, a little less than three-quarters (73.7%) of the respondents' expenses are covered by themselves or their spouses. Because this variable is skewed, we use its logged form as the dependent variable in our analyses.

Control Variables

For measures of family background, we draw on the 1988 parent survey for indicators of family socioeconomic status, including *family income*, *parents' highest level of education*, *mother's employment*, and *family composition*. Family income is an ordinal variable indicating total household income in 1987 (0=less than \$5,000, 13=more than \$100,000), parents' education is measured by dichotomous variables indicating the highest educational attainment of either parent (less than high school, high school, some college, or college or higher), mother's employment is a dichotomous variable indicating whether or not the adolescent's mother was currently employed (1=employed), and family composition indicates whether the child lives with two parents. Dichotomous variables indicating *race* (1=white) and *gender* (1=male) of the respondent were also included in the analyses. Last, we control for grade point average in the 9th grade (1=F, 12=A).

Results

Economic Self-Efficacy

Table 2 presents results from an Ordinary Least Squares (OLS) regression of economic self-efficacy during adolescence. Model 1 is the baseline model that examines the effects of family background and grade point average on economic self-efficacy in the 12th grade. Model 2 examines the influences of communication within the family and socialization towards work without taking into consideration background factors.⁴ Last, Model 3 includes both background characteristics and family socialization in order to assess the independent associations between socialization towards work and economic self-efficacy above and beyond differences in gender, race, family socioeconomic status, and prior academic achievement.⁵

Our analysis of economic self-efficacy during high school suggests that more advantaged youth, in terms of family background and academic performance, exhibit more confidence about their economic future. Model 1 shows that family background and grades significantly affect economic self-efficacy during high school. Family income exerts a weak positive influence ($p < 0.10$) and parents' education also has a positive effect on economic self-efficacy in high school. Children whose parents had some college education have higher efficacy than those whose parents had less than a high school education.⁶ Higher academic achievement is associated with higher levels of economic self-efficacy.

As shown in Model 2, some early socialization experiences in the family can impact an adolescent's beliefs about his or her economic capacity. Specifically, the more the child talks with his or her parents about their work, the greater his/her economic self-efficacy during high school. Surprisingly, however, other forms of family communication about work, such as visiting a parent's workplace and hearing the parents talk about work amongst themselves or with others do not influence economic self-efficacy. These findings suggest that direct communication about work between the parent and child might be the most effective form of socialization when it comes to shaping adolescents' perceptions of their own capacities to be successful in the economic realm. Other economic activities within the home can also shape one's economic self-efficacy. Consistent with Elder and Conger's (2000) findings, doing chores for pay is associated with somewhat greater economic self-efficacy ($p < .10$). Contrary to our initial hypothesis, however, we find that youths who received an allowance have *lower* levels of economic self-efficacy. The zero-order correlation between regular allowance receipt and economic self-efficacy is negative, which suggests that allowance may come to be perceived as a kind of entitlement, with connotations of economic *dependency* rather than *efficacy*.

Model 3 shows that the influence of family socialization towards work on economic self-efficacy cannot be fully explained by initial differences in background and prior academic performance. Net of family background and grades, parent-child discussions related to work still exert a positive influence on an adolescent's sense of future economic success, and those who ever received an allowance had lower levels of self-efficacy than those who did not.

Table 2. Regression of Economic Self-Efficacy on Family Socialization towards Work

	Model 1		Model 2		Model 3	
	b	(s.e.)	b	(s.e.)	b	(s.e.)
Background Variables						
Gender (1=male)	0.13	(0.19)	--	--	0.11	(0.19)
Race (1=white)	-0.25	(0.25)	--	--	-0.39	(0.25)
Family Income	0.08	(0.05)	+	--	0.08	(0.05) +
Family Composition	0.05	(0.23)	--	--	-0.04	(0.23)
Parent High School	0.28	(0.27)	--	--	0.27	(0.26)
Parent Some College	0.70	(0.27)	**	--	0.69	(0.27) *
Parent College or More	0.46	(0.31)	--	--	0.43	(0.32)
Mother's Employment	0.04	(0.28)	--	--	-0.27	(0.31)
G.P.A.	0.18	(0.04)	***	--	0.16	(0.04) ***
Family Socialization and Communication						
Hears Parents Discuss Work	--	--	-0.05	(0.13)	-0.10	(0.13)
Discusses Work with Parents	--	--	0.33	(0.13) *	0.32	(0.14) *
Visits Parents' Workplaces	--	--	0.01	(0.05)	0.00	(0.05)
Hours per Week on Chores	--	--	-0.01	(0.01)	0.00	(0.01)
Paid Chores (1=yes)	--	--	0.49	(0.26) +	0.31	(0.26)
Allowance Receipt (1=yes)	--	--	-0.52	(0.23) *	-0.55	(0.22) *
Intercept	10.13	(0.51)	11.80	(0.43)	10.38	(0.61)
R-square	0.07		0.03		0.09	

+ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001

The Transition to Adulthood

The transition to adulthood is often marked by events such as the completion of schooling, starting a career, marrying, and having children. We suggest that not only are these potentially intervening factors in the attainment of financial independence, but that they might also be influenced by economic self-efficacy. Using logistic regression, we next assess the influences of economic self-efficacy on current school enrollment, employment status, marital status, and parenthood.⁷ Results from these analyses are presented in Table 3.

The results, shown in Model 1 for each analysis, are consistent with prior research in that we find that young adults with more socioeconomically advantaged family backgrounds are more likely to still be enrolled in school and tend to delay marriage and parenthood. As of age 23-24, individuals with more highly educated parents are more likely to be enrolled in higher education and less likely to have had children than those whose parents have less than a high school degree. Those with higher family incomes during high school are less likely to be married or parents by 23-24. Males are more likely to be employed than females, and are less likely to have had a child. In addition, young adults with higher grade point averages in high school have higher odds of school enrollment and of being employed, whereas they have lower odds of having a child.

We also find that economic self-efficacy during adolescence has long-term influences on some facets of the transition to adulthood, independent of family background advantages and educational performance during high school. In particular, the greater one's self-efficacy during high school, the higher the odds that he or she will be employed, and the lower the odds he or she will have had at least one child by age 23-24 (see Model 2 across these variables). Thus, while economic self-efficacy increases the likelihood of working during young adulthood, it also tends to "delay" other facets of the transition to adulthood by postponing the onset of parenthood. Even though economic self-efficacy does not appear to influence school enrollment at age 23-24, the results presented in Table 4 indicate that it is positively related to educational attainment. This pattern suggests that perhaps those with the greatest economic self-efficacy have already completed higher education by early adulthood.

Table 3. Logistic Regressions of the Transition to Adulthood on Background and Economic Self-Efficacy

	In school			Employed		
	Model 1 b (s.e.) exp(b)	Model 2 b (s.e.) exp(b)		Model 1 b (s.e.) exp(b)	Model 2 b (s.e.) exp(b)	
Background Variables						
Gender (1=male)	0.23 (0.18) 1.26	0.22 (0.18) 1.25		0.90 (0.26) 2.46 ***	0.88 (0.26) 2.41 **	
Race (1=white)	-0.22 (0.24) 0.80	-0.21 (0.24) 0.81		0.46 (0.29) 1.58	0.48 (0.29) 1.62 +	
Family Income	0.05 (0.05) 1.05	0.04 (0.05) 1.04		0.12 (0.06) 1.12 +	0.11 (0.06) 1.11 +	
Family Composition	0.23 (0.23) 1.26	0.23 (0.23) 1.26		0.21 (0.28) 1.23	0.20 (0.29) 1.22	
Parent High School	-0.17 (0.25) 0.85	-0.18 (0.25) 0.83		0.09 (0.33) 1.09	0.05 (0.34) 1.05	
Parent Some College	0.73 (0.25) 2.09 **	0.70 (0.26) 2.01 **		-0.06 (0.33) 0.95	-0.16 (0.34) 0.86	
Parent College or More	1.16 (0.32) 3.19 ***	1.14 (0.32) 3.12 ***		-0.35 (0.40) 0.71	-0.42 (0.40) 0.66	
Mother's Employment	-0.08 (0.27) 0.92	-0.08 (0.27) 0.92		0.08 (0.36) 1.08	0.06 (0.36) 1.07	
G.P.A.	0.26 (0.04) 1.30 ***	0.25 (0.04) 1.28 ***		0.18 (0.05) 1.20 ***	0.17 (0.05) 1.18 **	
Economic Self-Efficacy	-- --	0.06 (0.04) 1.06		-- --	0.12 (0.05) 1.12 *	
Intercept	-2.45 (0.51)	-3.03 (0.65)		-1.17 (0.60)	-2.34 (0.78)	
Chi-square	114.10	116.15		39.23	44.72	
Degrees of Freedom	9	10		9	10	

+ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001

Table 3 Cont. Logistic Regressions of the Transition to Adulthood on Background and Economic Self-Efficacy

	Marital Status			Parenthood		
	Model 1 b (s.e.) exp(b)	Model 2 b (s.e.) exp(b)		Model 1 b (s.e.) exp(b)	Model 2 b (s.e.) exp(b)	
Background Variables						
Gender (1=male)	-0.14 (0.21) 0.87	-0.14 (0.21) 0.87		-0.73 (0.21) 0.48 ***	-0.72 (0.21) 0.49 ***	
Race (1=white)	0.35 (0.29) 1.42	0.36 (0.29) 1.44		-0.55 (0.25) 0.58 *	-0.58 (0.25) 0.56 *	
Family Income	-0.13 (0.06) 0.88 *	-0.14 (0.06) 0.87 *		-0.21 (0.06) 0.81 ***	-0.20 (0.06) 0.82 ***	
Family Composition	0.04 (0.25) 1.05	0.04 (0.25) 1.04		-0.12 (0.24) 0.88	-0.11 (0.24) 0.89	
Parent High School	0.21 (0.29) 1.24	0.20 (0.29) 1.22		0.02 (0.26) 1.02	0.04 (0.26) 1.04	
Parent Some College	0.17 (0.29) 1.18	0.13 (0.30) 1.14		-0.23 (0.27) 0.80	-0.17 (0.27) 0.85	
Parent College or More	-0.21 (0.37) 0.81	-0.23 (0.37) 0.79		-1.23 (0.40) 0.29 **	-1.19 (0.40) 0.30 **	
Mother's Employment	-0.22 (0.30) 0.80	-0.22 (0.30) 0.80		0.09 (0.30) 1.09	0.10 (0.31) 1.10	
G.P.A.	-0.01 (0.04) 0.99	-0.02 (0.05) 0.98		-0.24 (0.04) 0.79 ***	-0.22 (0.04) 0.80 ***	
Economic Self-Efficacy	-- --	0.04 (0.05) 1.05		-- --	-0.08 (0.04) 0.92 *	
Intercept	-0.66 (0.55)	-1.11 (0.73)		3.06 (0.55)	3.93 (0.71)	
Chi-square	14.43	15.39		121.23	125.07	
Degrees of Freedom	9	10		9	10	

+ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001

Status Attainment

Another mechanism through which economic efficacy could impact financial independence is through one's own status attainments, specifically educational attainment and income. In Table 4, we present the results of a multinomial logistic regression of educational attainment (with high school or less as the reference category), and in Table 5, we report the results of an OLS regression of income. Our findings for both of these outcomes are consistent with classic research on status attainment. Higher family income and parents' education are associated with increased odds of completing at least some college or more as opposed to a high school degree. Additionally, men earn more than women, and whites earn more than non-whites. Somewhat unexpectedly, parents' education has a negative effect on young adult income. The negative relationship between parents' education and income in 1997 is probably due to the fact that those with more educated parents are also more likely to still be enrolled in school themselves, as shown in Table 3. Not surprisingly, grade point average in high school is also positively associated with educational attainment in young adulthood.

Table 4. Multinomial Logistic Regression of Educational Attainment on Background and Economic Self-Efficacy

	Model 1						Model 2					
	Some College vs. High School or Less			College or More vs. High School or Less			Some College vs. High School or Less			College or More vs. High School or Less		
	b	(s.e.)	exp(b)	b	(s.e.)	exp(b)	b	(s.e.)	exp(b)	b	(s.e.)	exp(b)
Background Variables												
Gender (1=male)	-0.28	(0.20)	0.76	-0.34	(0.28)	0.71	-0.31	(0.21)	0.73	-0.39	(0.28)	0.68
Race (1=white)	-0.09	(0.27)	0.92	-0.01	(0.37)	0.99	-0.04	(0.27)	0.96	0.07	(0.38)	1.07
Family Income	0.15	(0.06)	1.16 **	0.14	(0.07)	1.14 *	0.14	(0.06)	1.15 *	0.12	(0.07)	1.12
Family Composition	0.03	(0.25)	1.04	0.42	(0.35)	1.53	0.02	(0.25)	1.02	0.43	(0.36)	1.54
Parent High School	0.39	(0.26)	1.48	0.13	(0.43)	1.14	0.35	(0.27)	1.41	0.09	(0.44)	1.09
Parent Some College	0.93	(0.29)	2.52 **	1.25	(0.41)	3.47 **	0.80	(0.29)	2.24 **	1.13	(0.41)	3.11 **
Parent College or More	0.51	(0.39)	1.67	2.24	(0.47)	9.36 **	0.41	(0.40)	1.51	2.18	(0.47)	8.82 ***
Mother's Employment	0.14	(0.31)	1.15	0.04	(0.42)	1.04	0.12	(0.31)	1.13	0.02	(0.42)	1.02
G.P.A.	0.24	(0.05)	1.27 ***	0.77	(0.08)	2.16 ***	0.21	(0.05)	1.24 ***	0.74	(0.08)	2.11 ***
Economic Self-Efficacy	--	--		--	--		0.19(0.05)	1.21 ***		0.25(0.06)	1.29 ***	
Intercept	-2.62	(0.56)		-8.56	(0.97)		-4.69	(0.76)		-11.32	(1.25)	
LRT Chi-square	280.15						303.93					
Degrees of Freedom	18						20					

+ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001

Even after accounting for these effects of family background and grades on status attainment, we still see a positive relationship between economic self-efficacy during high school and educational attainment and income. Similar to the findings of Grabowski et al, (2001), Model 2 in Table 4 shows that including economic self-efficacy significantly contributes to the overall model fit. A greater sense of efficacy in the economic realm increases both the odds of completing some college and the odds of completing college or more, as opposed to completing a high school degree or less. In addition to its positive influence on educational attainment, we also find that economic self-efficacy in adolescence is quite beneficial for income attainment in young adulthood, as shown in Table 5. These results suggest that early development of self-confidence in one's own economic capacity has long term benefits for status attainment, net of family background and academic performance.

Table 5. Regression of Income on Background and Economic Self-Efficacy

	Model 1			Model 2		
	b	(s.e.)		b	(s.e.)	
Background Variables						
Gender (1 = male)	2.06	(0.78)	***	2.09	(0.77)	**
Race (1 = white)	2.05	(1.09)	**	2.08	(1.08)	
Family Income	0.38	(0.21)		0.34	(0.21)	
Family Composition	-1.51	(1.01)		-1.52	(1.00)	
Parent High School	-0.76	(1.13)		-0.93	(1.12)	
Parent Some College	-2.14	(1.14)		-2.46	(1.13)	*
Parent College or More	-3.75	(1.33)	**	-3.98	(1.33)	**
Mother's Employment	-0.32	(1.19)		-0.45	(1.18)	
G.P.A.	0.30	(0.18)		0.20	(0.19)	
Economic Self-Efficacy	--	--		0.53	(0.18)	**
Intercept	11.97	(2.27)		6.66	(2.88)	
R-square	0.04			0.06		

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Financial Independence

The question of what factors foster financial independence in young adulthood still remains. We now turn to the influences of economic self-efficacy during adolescence on financial independence. The results of this analysis are presented in Table 6. Model 1 assesses the role of family background and grades on the logged percent of expenses that are covered by the respondent and his/her spouse. Model 2 adds economic self-efficacy in order to assess its independent contribution to financial independence net of the effects of family background and educational performance. Finally, Model 3 examines whether any of these relationships are mediated through status attainment and/or other markers of the transition to adulthood. Because it is plausible to assume that the process of achieving financial independence would differ for males and females, we estimated interactions of gender with economic efficacy, the family socialization and communication indicators, and the Wave 9 attainments. Therefore, Model 3 also includes interactions between gender and employment status, marital status, and parenthood.⁸

The results from Model 1 indicate that background factors have little effect on financial independence in young adulthood. It is interesting to note that more advantaged youth are no more or less financially independent at the age of 23-24 than those who grew up in more socioeconomically disadvantaged households, and that being financially self-reliant is not associated with early academic performance. Instead, the strongest background predictors of financial independence are gender and race. Males report greater financial independence than females, and whites are more economically self-sufficient than non-whites.

Model 2 shows that early adult financial independence is positively associated with economic self-efficacy during adolescence. Those who felt more efficacious when it came to their economic futures were indeed more likely to be financially self-reliant by age 23 or 24. It is notable that this construct, measured in the senior year of high school, is still associated with financial independence so many years later, even when controlling for relevant background factors.

Table 6. Regression of Financial Independence on Background, Economic Self-Efficacy, and Attainments

	Model 1		Model 2		Model 3	
	b	(s.e.)	b	(s.e.)	b	(s.e.)
Background Variables						
Gender (1 = male)	0.34	(0.11)	**	0.33	(0.11)	**
Race (1 = white)	0.29	(0.14)	*	0.31	(0.14)	*
Family Income	0.02	(0.03)		0.01	(0.03)	
Family Composition	0.00	(0.13)		0.00	(0.13)	
Parent High School	0.01	(0.15)		-0.02	(0.15)	
Parent Some College	-0.06	(0.15)		-0.12	(0.15)	
Parent College or More	-0.15	(0.18)		-0.19	(0.18)	
Mother's Employment	-0.22	(0.16)		-0.23	(0.16)	
G.P.A.	0.00	(0.02)		-0.01	(0.02)	*
Economic Self-Efficacy	--	--		0.08	(0.02)	***
Wave 9 Attainments						
School Enrollment	--	--		--	--	
Employment Status	--	--		--	--	
Marital Status	--	--		--	--	
Parenthood	--	--		--	--	
Income	--	--		--	--	
Some College	--	--		--	--	
College or More	--	--		--	--	
Gender x Employment Status	--	--		--	--	
Gender x Marital Status	--	--		--	--	
Gender x Parenthood	--	--		--	--	
Intercept	3.66	(0.30)		2.83	(0.38)	
R-square	0.03			0.05		

+ p < 0.10, * p < 0.05, ** p < 0.01, *** p < 0.001

Model 3, however, indicates that the markers of the transition to adulthood and status attainments mediate the relationship between economic self-efficacy and financial independence in young adulthood. First, as shown earlier, economic self-efficacy formed during high school increases the odds of employment (Table 3); this in turn increases financial independence, especially among women. Second, economic self-efficacy decreases the odds of having at least one child by age 23-24 (Table 3), which is negatively related to financial independence for women. Third, higher adolescent economic self-efficacy increases educational attainment and income (Tables 4 and 5), which are associated with greater independence in supporting oneself. These findings suggest that although economic self-efficacy contributes to the accomplishment of financial independence, its influence is primarily indirect, through the youth's own status attainments. The significant interactions indicate that the process of attaining financial independence differs for men and women. Young adult women are more dependent on marriage and employment for financial self-sufficiency than are men (i.e., the effect of marriage is .84 for women, but only .26 [.84-.58] for men; the effect of employment is 1.34 for women, but only .24 [1.34-1.10] for men). Parenthood, in contrast, lessens females' independence (-.41), while increasing it somewhat for men (-.41+.66 = .25).

Discussion

This paper has examined the role of family socialization towards work in adolescence in fostering economic self-efficacy, and the subsequent influence of self-efficacy on the transition to adulthood, status attainment, and financial independence in young adulthood. From this research, it appears that for young adults, experiences in the family that increase the salience of market work – that is, communicating with one’s parents about their work – foster a sense of confidence in the economic realm. A household climate that emphasizes verbal communication about work between family members, including discussions with fathers and mothers, is likely to increase the psychological salience of work to adolescents. Their own anticipation of being effective in the economic sphere is thereby heightened. In addition, we find that self-efficacy has a direct impact on financial independence in young adulthood though educational and occupational attainments as well as the delay of family formation in the early 20s.

This paper sets forth preliminary evidence that the development of economic competency is a long-term process that commences through experiences in the family setting, well before the onset of adulthood. Socialization towards work in the family context appears to indirectly enhance young adults’ capacities to support themselves. The overall pattern of findings suggests that micro-level interpersonal relations and interactions may be key to understanding the processes through which families foster the economic self-efficacy and independence of their children. These findings point to the potential for positive work-family linkages. Parents can indeed promote the development of economic self-efficacy in their teenage children by enabling their work to influence what goes on at home, by talking about their jobs to their children. In some circumstances, for example, in entrepreneurial settings or on the farm (Elder and Conger, 2000) the blurring of the boundaries between work and home may occur very naturally, encouraging interactions about work. In large bureaucratic settings, there may be days set aside for children to be brought to work. Other settings (particularly those that may be highly regulated, highly technical, or dangerous) may be less “family-” or “child-friendly.” No matter what the setting, informal socialization towards work, like just talking about work, can have positive consequences for adolescents’ confidence about their financial futures and their actual capacities to become economically independent in early adulthood. The findings raise caution, however, about potentially adverse effects of monetary exchanges in the family. Contrary to many parents’ beliefs, and prescriptive advice to give children a regular allowance in the family guidance literature, we find that those who ever received an allowance were less economically efficacious in adolescence than those who did not receive this regular stipend; moreover, allowance receipt was associated with restricted educational attainment.

This study has some noteworthy limitations. First, all data (except the socio-economic background variables) were obtained from the young people themselves. Much better understanding of the family dynamics that foster economic independence would be obtained if parents’ own orientations could be taken into account. While there is some understanding of parent’s views with respect to the purposes of allowance (Miller and Jung, 1990), we know little about parents’ intentions with respect to communications about work, or about the reasons for assigning chores. For example, do parents who have higher occupational aspirations for their children deliberately make a point of talking to them about their work? Do parents who give their children allowance or offer money in exchange for chores encourage financial dependency in other ways? Even though we know the frequency of parent-child discussion about work, we know nothing of the content of these communications. They may involve direct encouragement of economic self-efficacy in children, or they may provide other messages from which adolescents derive this positive self-concept. More direct study of parental intentions and the content of family interactions, surrounding both market work and housework, would enable assessment of whether the communications among family members observed here mediate important differences in parental goals.

Despite the limitations of this study and the further questions remaining, the long duration of this project, with surveys spanning a highly formative period of economic socialization and attainment, has enabled us to observe the impacts of family and work experiences as they occur, rather than relying on retrospective recall. The findings highlight the significant influence of economic socialization in the family setting on the development of an adolescent’s confidence in his/her economic capacities, which paves the way for adult financial independence. It is especially noteworthy that in this study six years separated the measurement of economic efficacy and the outcomes of interest; economic efficacy was measured at age 17-18, the status transitions and attainments, at age 23-24. The findings demonstrate

the enduring significance of economic self-efficacy in assuring a successful transition to adult roles and the achievement of economic independence. The more efficacious adolescents were more likely to be employed in early adulthood; they also had higher educational attainment and income. Furthermore, adolescent economic efficacy was associated with a delay in parenthood, enabling the more efficacious youth to invest more in their human capital through higher education. Whereas economic efficacy had a positive relationship to economic independence, this relationship was entirely mediated by the transitions and attainments that led to financial self-sufficiency.

It might be countered that self-efficacy in adolescence should not be considered to have causal force. Instead, those adolescents, on the basis of their socioeconomic backgrounds and associated advantages, simply understand that they are likely to have more positive economic futures than those facing greater obstacles. According to this view, the relationship between efficacy and the outcomes we have studied is spurious. This argument parallels a long-standing criticism of studies that prioritize psychological orientations more generally, including aspirations, as determinants of educational and occupational attainments (Roberts, 1968). Achievement-related orientations are seen as having no causal role in the process of attainment; they are instead mere products of actual achievements and more or less advantaged social location. While this position is plausible, the fact that numerous indicators of advantage and achievement are controlled in our analysis appears to undermine such criticism. Even with gender, race, family income, family composition, and parental education controlled, we still find that adolescent self-efficacy is positively related to educational attainment, employment, and income in early adulthood. The adolescent's grade point average is, as might be expected, also a significant influence on these positive outcomes, but this indicator of ability and academic performance is also controlled. The findings indicate that efficacy is, in fact, an important resource for the transition to adulthood and for the processes of socioeconomic attainment that promote early adult economic sufficiency. They call for more active interventions on the part of the family, as well as other institutions, to stimulate positive self-conceptions of efficacy in the workplace so as to enhance socioeconomic attainments and foster financial independence.

We recognize that institutional structures and changes, including trends in educational enrollment and financing, labour market opportunities, welfare policies, and taxation mechanisms (Smeeding and Phillips, 2002), are of critical importance, influencing the likelihood that individuals will experience economic difficulties during the transition to adulthood as well as at other junctures in their lives. Such macro-level phenomena give rise to the societal distribution of income, the prevalence of poverty in any given historical period, and the effectiveness of various asset accumulation strategies for particular social groups (Shapiro and Wolff, 2001). Moreover, the effectiveness of individual agentic processes importantly varies across time and place depending on the configuration of structural opportunities (Shanahan, Elder, and Miech, 1997). Nonetheless, we contend that a full understanding of financial independence, along with other forms of adaptation to the challenges of adulthood, requires consideration of both structure and agency. The capacity of individuals to take advantage of the particular, historically-specific opportunities available to them as they make the transition to adulthood, and to surmount the obstacles that they encounter in seeking their economic goals, will depend on a multitude of resources, including psychological assets and behavioural patterns acquired during the course of their prior development.

Endnotes

- ¹ Moore, Peterson and Furstenberg (1986) find that that this is only the case for daughters of parents with traditional values.
- ² We examined whether a family socialization index comprised of these single indicators (hearing parents talk about work, discussing work with parents, and visiting parents' workplaces) would be more appropriate; however, their low alpha reliability (0.50) suggested that they should be analyzed separately in our model.
- ³ It would be interesting to consider household income as well as personal income, given that our measure of financial independence also includes spouses' earnings. However, information on household income is not available in the data for 1997.
- ⁴ We also examined whether family communication about work over time (measured by an average over 9th, 10th, and 11th grades) impacted economic self-efficacy. This analysis yielded similar results.

- ⁵ We also tested for interactions between gender and family socialization. The effects were not statistically significant, suggesting that the relationship between family socialization and communication and economic self-efficacy in adolescence is similar for boys and girls.
- ⁶ When grade point average is not included in the equation, children of parents with a four-year college degree or more also have higher efficacy than those whose parents had the lowest level of education. The pattern suggests that the most highly educated parents increase their children's self-efficacy by fostering high grade point averages.
- ⁷ In preliminary analyses, we found that family socialization towards work is not correlated with the transition to adulthood and financial independence beyond its relationship with economic self-efficacy. Thus, for parsimony, these variables are omitted from subsequent models.
- ⁸ We initially included interactions between gender and all indicators of the transition to adulthood; we present only those that are statistically significant.

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Handling attrition and non-response in longitudinal data

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Abstract

Procedures for handling attrition and missing data values in longitudinal studies are discussed. A multiple imputation (MI) strategy is developed that can be applied to complex multilevel data. It is both general and statistically efficient and estimation software is available. An example of its use is given.

Keywords

Multilevel, attrition, longitudinal, multiple imputation, weighting, latent normal model.

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Introduction

Attrition in longitudinal studies is often seen as a serious problem for two reasons. First, the loss of individuals over time will often result in a sample size, after a few occasions or 'sweeps', very much smaller than the initial sample size. Thus, for example Hawkes and Plewis (2006) report that just 71% of the target sample at sweep 6 (42 years) of the National Child Development Study provided information, compared with 99% at the start of the study. They also point out that 11% of the sample at sweep 6 had missed one or more earlier sweeps. For those analyses that utilise data at more than one occasion, if only those individuals with data at all such occasions are used in the analysis this will result in a loss of efficiency. Note that we use the term 'attrition' to mean any pattern of loss of individual records over time, including those cases where individuals may return to a study after missing measurement occasions.

Secondly, loss may not occur at random so that the remaining sample may be biased with respect to the variables being analysed. In longitudinal studies, at any given occasion the characteristics of subsequent losses will be known and these can be compared with those who are followed up. If biases are detected then suitable weights can be introduced to compensate for this, and this is the traditional approach to dealing with attrition.

The present paper sets out a general model-based approach to dealing with attrition in longitudinal studies. It does this by embedding the problem within a general approach to handling missing data and the procedure will, in principle, handle both the loss of individual records over time and the loss of individual data items. In the next section, we summarise briefly the weighting approach. For further details of weighting, including the use of auxiliary variables see, for example, Schouten and De Nooig (2005). Following this we then describe our general model for attrition and give an example.

Weighting procedures

The methodology for computing weights specifically in order to compensate for 'informative' attrition that leads to biases, involves procedures for estimating the probability of a sample member responding, for each sample member at each occasion, as a function of sample member characteristics. Hawkes and Plewis (2006) provide a useful description of a model-based approach to this. The resulting (inverse) probabilities are then used in standard ways in subsequent analyses. One of the problems with such procedures is that response may be partial. Thus, for example, all individuals may respond to a set of educational variables but not to health variables at a particular occasion. In this case, we would not use weights to adjust for attrition when analysing the educational data but we would wish to do so if health variables were also being analysed. This will complicate matters generally, for example because successive analyses may be based upon different numbers of individual cases. A further problem is that for a particular individual the weights will generally change from occasion to occasion, depending on the possibly changing response patterns across the sample, which may alter the joint distribution of respondent characteristics, and this will create difficulties when conducting analyses across several occasions.

Another set of issues when using weights is that a traditional weighting approach will generally lose data information. For example, suppose we wish to regress a time 2 variable on a set of time 1 variables with attrition occurring. Weights can be obtained in various ways but the weighted analysis will then be carried out using only the cases with measurements at both occasions. This ignores the information, from one occasion even though lost at another, that is not incorporated in weights but may be available, for example, from auxiliary variables or further covariates in a model. A similar problem arises in the case mentioned above where there is a differential response to, say, health and educational variables. As we will show, our proposed procedure avoids this problem.

In the next section we describe how attrition can be formally considered within a missing data framework.

Missing data and attrition

We shall start by making the simplifying assumption that data are missing at random (MAR) conditional on a set of 'conditioning variables' that have been collected for both respondents and non-respondents. The conditioning variables might be variables collected at the start of the survey or they may be 'auxiliary variables' that are of no analytical interest but may be available and associated with the propensity to be missing. In addition to their use for attrition purposes, such auxiliary variables may also be used to deal with non-response at the first stage of data collection. As we shall explain below, these auxiliary variables will not generally belong to the statistical model being fitted, the so called 'Model of Interest' (MOI) and are introduced alongside the MOI and linked to it. These might be interviewer characteristics, neighbourhood characteristics etc. The MAR assumption is crucial and underlies our modelling procedure (see for example Little and Rubin, 1987).

An individual record that is missing is a special case of missing data where all the variables at that occasion are missing. The existence of known conditioning variables for such records allows us to use multiple imputation (MI) where we condition on these variables. Thus, formulating attrition in this way will allow us to use a common consistent approach to handling item missing data and attrition within a single model. It will also be efficient since it allows us to use all the available data on individuals and not simply those data on variables that are present across all the occasions being used in an analysis, as in the weighting approach described above.

In the next section we look at a full model-based procedure for handling the attrition problem and this is followed by a discussion of multiple imputation methods.

A full model-based procedure for informative attrition and item missing data

Where we cannot assume MAR and attrition is informative it may be possible to adopt a fully model-based procedure. In this case we need to write down an explicit model for the probability of attrition and link this to the model of interest (MOI) that we wish to fit. Consider a simple situation where the MOI is given by (1) and the response probability model is given by (2).

$$y_{1i} = \beta_0 + \beta_1 x_i + e_{1i} \quad (1)$$

$$\Pr(\text{response observed}) = \alpha_0 + \alpha_1 z_i + e_{2i} \quad (2)$$

where the \mathbf{Z} is an auxiliary variable (or more generally a set of variables) that predicts the probability of a response (\mathbf{Y}) being observed and is uncorrelated with the random effects e_{1i} , e_{2i} in (1) and (2). The two models are linked by assuming

$$E(e_{1i} e_{2i}) = \sigma_{e12} \neq 0$$

In practice we would use a nonlinear link function for the response probability such as the *probit*, and that particular function would allow us to formulate the situation conveniently in terms of a bivariate normal model in the case where e_{1i} is normally distributed.

The existence of $\sigma_{e12} \neq 0$ is a statement that the propensity for a record to be missing is related to the response in the MOI or that the attrition is informative. In such a case a joint analysis of (1) and (2) will yield unbiased estimates. This is conveniently carried out in a Bayesian framework where the missing values are treated as parameters to be estimated and samples from the appropriate posterior distributions are chosen at each iteration of a Markov Chain Monte Carlo (MCMC) algorithm (see for example Gilks et al., 1996).

While such a full model based procedure is often attractive, it does not deal with the case where individual items in a record additionally may be missing. In order to extend this model to the case where there is item missing data, we can use MCMC, assuming MAR for the missing items, and treating all the missing values as additional parameters, but this becomes computationally very time-consuming. Further references are those of Nathan (1983), Nathan and Holt (1980) and Pfeiffermann (2001). The multiple imputation procedure described below will handle attrition where whole records are missing as well as missing items.

Random multiple imputation for missing data

Imputation is a procedure for handling missing data that works by constructing a complete data set, replacing every missing value by an 'imputed' value that is generated by a specified algorithm. The completed data set can then be analysed in the usual manner. Several imputation methods have been proposed but here we shall consider only the now standard method of Random multiple imputation first introduced by Rubin (1987) and an application to survey data can be found in Rubin (2004). A useful introduction to imputation can be found at www.missingdata.org.uk which also provides macros for fitting certain kinds of multiple imputation for multilevel structures using the multilevel modelling package MLwiN (Rasbash et al, 2008).

If we have a survey where some individuals do not respond, but we do have some auxiliary information about them, for example characteristics of where they live, reason for non-response, characteristics of interviewer, or in a longitudinal study earlier variable values, then formally we can view this as a missing data problem. The full set of variables is considered to be the survey items plus the auxiliary data and in the case of attrition all the survey items at that occasion are missing. In addition we can have missing survey items for respondents, perhaps by design as in rotation sampling, and even missing data for some auxiliary variables. In imputation we condition on all the observed variables, including the auxiliary variables, when creating our imputed values, and we describe how this is actually done below. If we have an efficient procedure for handling general patterns of missing data then this will lead to a single comprehensive analysis model that simultaneously will handle what is conventionally described as attrition in longitudinal data (complete missingness at certain occasions) and conventional missing data situations where just some variable values are missing.

When carrying out imputation, while it is important that all relevant auxiliary variables are conditioned upon, these do not all have to be included in the final model of interest (MOI). It is necessary, however, that any variable used in the MOI is used in the imputation stage. Thus, for example, if a multilevel structure is part of the MOI, then a relevant multilevel imputation procedure should be used. This general requirement may create problems if imputed data sets are being created for secondary data analysis so that care needs to be taken.

A simple example of multiple imputation

We consider dividing into sets the variables of interest in our data. Set A are those variables that constitute the response and predictors in the MOI, which may for instance be a linear or generalised linear model. If the model is multilevel the predictors will include those variables defining the random effects. Set B is a set of further conditioning variables that do not feature in the model of interest but which are correlated with those in set A. Set C is the union of sets A and B. Note that we include here as conditioning or auxiliary variables any variable not in the model of interest, whether collected within the survey or outside it; the sole requirement is that for some set B variables, information is available on both respondents and non-respondents. Even this assumption can be relaxed, however, if some auxiliary variables have missing values, by including these variables as responses rather than predictors at the MI stage (see below).

The procedure has two stages. In the first stage we set up a (possibly multilevel) model where the set A variables are treated as a multivariate response vector, each response regressed on just an intercept.¹ To illustrate, consider a simple regression model where we have a model with a single, normal, response, y and a single, normal predictor, x . The model of interest is

$$y_i = \beta_0 + \beta_1 x_i + e_i \quad (3)$$

and we may have missing data in both X and Y . We now set up an 'imputation' model that has all the variables as responses with just an intercept predictor, i.e.

$$\begin{aligned} y_i &= \alpha_1 + e_{1i} \\ x_i &= \alpha_2 + e_{2i} \\ \begin{pmatrix} e_{1i} \\ e_{2i} \end{pmatrix} &\sim N \begin{pmatrix} 0 & \sigma_1^2 \\ 0 & \sigma_2^2 \\ \sigma_{12} & \end{pmatrix} \end{aligned} \quad (4)$$

and (4) is just a bivariate normal model where each response is modelled by its mean.

By fitting model (4) we can incorporate missing as well as observed responses using the procedure described below. If we fit this model we will obtain the intercept estimates, the residual variances and the covariance. We will also have estimates for the residuals $\hat{e}_{1i}, \hat{e}_{2i}$, obtained by subtraction.

Suppose now that an x value is missing so that we can no longer estimate the corresponding residual by subtraction. Nevertheless we do have an estimate of the *distribution* of x , namely $N(\hat{\alpha}_2, \hat{\sigma}_2^2)$, that is a normal distribution with estimated mean $\hat{\alpha}_2$ and estimated variance $\hat{\sigma}_2^2$.

We can therefore generate a value at random from this distribution and this becomes our imputed value. In practice we fit (4) using Markov Chain Monte Carlo Methods. After each of a set of suitable chain intervals, for example at iteration 1000, 2000....., we randomly sample a complete set of imputed values for each missing value. The intervals between these sampled sets should be long enough to guarantee (approximate) independence for the sampled values. This will be done n times, providing a single set of imputed plus observed values after each of n intervals, yielding multiple (n) 'complete' datasets. The value of n required will depend on the application, but for a multilevel model may need to

¹ We may choose at this stage to place one or more fully observed set B variables as predictors for this set of responses. This is the standard procedure for traditional weighting methods. There may be computational advantages where there are a large number of variables. In multilevel modelling we will also have further random coefficients for some of these predictors. Note, however, that where we have missing values in the set B variables, either for those cases that are missing or those that are observed, they must be treated as responses.

be as high as 20 or more. The original model of interest (3) is fitted this number of times yielding n sets of parameters. These are then averaged to provide the final estimates. The details of this procedure are given at www.missingdata.org.uk.

We note that in fact the parameters for model (3) can, for this simple case, be derived from the parameters fitted to model (4), the latter being sufficient. For more complex models including multilevel ones, however, there will typically be no straightforward way to do this, as in the following case.

Suppose that we now have an auxiliary variable, Z , that is associated with the propensity to be missing. We can extend (4) as follows

$$\begin{aligned}
 y_i &= \alpha_1 + \gamma_1 z_i + e_{1i} \\
 x_i &= \alpha_2 + \gamma_2 z_i + e_{2i} \\
 \begin{pmatrix} e_1 \\ e_2 \end{pmatrix} &\sim N \begin{pmatrix} 0 & \sigma_1^2 \\ 0 & \sigma_{12} & \sigma_2^2 \end{pmatrix}
 \end{aligned} \tag{5}$$

where the missing values now depend on Z so that, if the relationships are as assumed in (5), conditional on Z we can assume we have MAR for the imputed values. If any of the values of Z were missing then we can incorporate Z as a response variable in (5) and this would have a similar effect. This procedure is readily extended to more complex structures, including multilevel ones such as that described later in an example.

We have assumed above that the data are multivariate normal and most treatments of multiple imputation make such an assumption. However, many predictor (and response) variables are binary, ordered or nominal. Treating binary or ordered variables as normal can lead to biases, especially where there are very few cases in one or more categories. Treating a p -category nominal variable using a set of $p-1$ (0,1) indicator categories and assuming multivariate normality for these, likewise can lead to biases. This is where a 'latent Normal' variable approach may be used. To illustrate this, consider the case where Y is normal but X is a binary variable, for example whether or not a student passes an examination.

Suppose we have a normally distributed underlying variable, with a variance fixed at 1 to ensure identifiability, and mean μ

$$z_i \sim N(\mu, 1),$$

Where we observe an exam pass, that is a positive (=1) response for our binary variable x if z is positive, that is

$$\begin{aligned}
 z_i &= \mu + e_i > 0 \text{ or} \\
 e_i &> -\mu
 \end{aligned}$$

So that we have

$$\text{Prob}(x=1) = \text{Prob}(e_i > -\mu) = \int_{-\mu}^{\infty} \phi(t) dt = \int_{-\infty}^{\mu} \phi(t) dt \tag{6}$$

where $\phi(t)$ is the standard normal density function. Equation (6) is a probit characterisation and given an observed binary response (0 or 1) and an estimate for μ we can randomly sample a value from the underlying normal distribution Z at each cycle of our MCMC algorithm. This can be done in such a way that Y, Z have a bivariate normal distribution and we can then apply the missing data procedure we have already described. This provides us with imputed values for the Z distribution, and we can then invert the procedure we used for sampling Z to obtain a randomly imputed value for X .

Similar procedures can be used for ordered or unordered categorical data and also for non-normal continuous data and details are given in Goldstein et al (2009).

Software for carrying out the computations has been developed under the auspices of an ESRC project REALCOM, and details together with software can be found at

<http://www.cmm.bristol.ac.uk/research/Realcom/index.shtml>. In release 2.1 of MLwiN Rasbash et al., (2008) it is possible to utilise the REALCOM extensions straightforwardly from within MLwiN itself by specifying the appropriate features of the MOI.

Note that so far we have made no distinction between type of non-response (refusal, non contact etc.), and that is equivalent to assuming that the relationship (as expressed in the parameters of our imputation/prediction model) is the same for different types. If this is felt to be unreasonable then we can allow for this in the imputation model. This can be done by including auxiliary variables associated with different types of non-response.

Care needs to be taken to ensure that the conditioning for the missing values is adequate. The advantage of the MI approach is that auxiliary variables not in the model of interest can be conditioned upon at the imputation stage. An alternative to MI, known as double robustness estimation (see Carpenter et al., 2006) uses weights based upon estimated missingness probabilities and may be useful in cases where the pattern of missingness is relatively simple (e.g. confined to a single variable), but difficult to implement in the general case. It has the theoretical advantage that, if either (i) a correct model for the probability of being missing is specified, or (ii) a correct model for just the conditional mean of the missing given observed data is specified, it then provides consistent and nearly efficient estimates. Thus only one of the two criteria needs to be satisfied. In practice, however, if a correct model is available for the probability of being missing (i.e. the variables responsible for missingness can be measured) then the relevant variables can also be incorporated into the MI process.

An example

We use an educational data set of measurements on 4059 students in 65 schools in London who have test scores and other measurements made at two occasions, at the end of primary schooling and prior to starting at secondary school at the age of 11 years (year 6), and at age 16 (year 11). In particular, at age 11 we have a reading test score – the London Reading Test (LRT) and at 16 an average examination score (EXAMSCORE) derived from grades obtained in the General Certificate of Secondary Examination (GCSE). Full details of the dataset can be found in Goldstein et al (1993).

To illustrate the imputation procedure we fit a simple 2-level model where EXAMSCORE (Y) is related to LRT (X_1) and gender (X_2) as follows

$$y_{ij} = \beta_0 + \beta_1 x_{1ij} + \beta_2 x_{2ij} + u_j + e_{ij}, \quad u_j \sim N(0, \sigma_u^2), \quad e_{ij} \sim N(0, \sigma_e^2) \quad (7)$$

We first fit the model to the full data set and we will then drop data values and examine different procedures for handling the resulting dataset that includes missing values.

Table 1 gives the maximum likelihood parameter estimates for the model fitted to the full dataset.

Parameter	Estimate (standard error)
Intercept	-0.095 (0.043)
Reading test	0.560 (0.012)
Gender (girl-boy)	0.171 (0.033)
Level 2 variance	0.088 (0.017)
Level 1 variance	0.562 (0.013)

We see from these results that girls do significantly better than boys after adjusting for initial reading test score. In this sense we can infer that girls make more progress between ages 11 and 16 than boys. We also have a measure of verbal reasoning ability at age 11 for these students that is associated with progress. There are 3 categories that were originally defined to comprise the lowest 25% of ability scores, the next 50% and the highest 25%. The middle category in our sample contains 58% of the students and for these we assume that a random 50% drop out and for these we set the EXAMSCORE to be missing. The original values are retained for use in the imputation model as explained below.

In addition we randomly set a third of the LRT values to be missing. Altogether 53% of the student records have at least one missing value. The resulting estimates using 'listwise deletion' of all such records gives the results in Table 2.

Table 2. Exam score related to gender and reading test score with listwise deletion of pupils with any missing data. Two level variance components model (7). Maximum likelihood estimates.

Parameter	Estimate (standard error)
Intercept	-0.041 (0.052)
Reading test	0.576 (0.017)
Gender (girl-boy)	0.125 (0.047)
Level 2 variance	0.103 (0.022)
Level 1 variance	0.571 (0.019)

We see that, the girl – boy difference has decreased, the LRT coefficient has increased and both variances have increased, with increases in all the standard errors resulting from the smaller sample size.

We now carry out an imputation analysis where, in the imputation model, the exam score and LRT are responses, since these contain missing data, and we condition both on gender and the (known) verbal reasoning group with the results shown in Table 3. The verbal reasoning group variable is here treated as an auxiliary variable known to be related to the propensity to be missing and also to the LRT score and EXAMSCORE, and is available both for those with full data and those with missing data. Thus, while all the variables in the MOI are used in the imputation model, the additional use of the verbal reasoning group is to correct for the bias we have (artificially) introduced which depends on the verbal reasoning group value. We note that our analysis is for illustration purposes only. If we wished to demonstrate how MI in general recaptures the original parameter estimates we would need to carry out a full set of simulations using multiply generated datasets, rather than just one illustrative analysis as here.

For the MCMC estimation we have used a 500 burn in with 10000 iterations, sampling every 500 to give 20 completed data sets. We see that the final parameter estimate for gender in Table 3 (below) is rather closer to the original value than in Table 2, and the reading test coefficient and the variance estimates in Tables 1, 2 & 3 vary, reflecting the sampling variability associated with a single randomly simulated set of missing values. It is, however, the reduction in the standard errors that is most noticeable, showing that we have gained in precision.

Table 3. Exam score related to gender and reading test score. Two level variance components model (7). Multiple imputation estimates with 20 completed datasets.

Parameter	Estimate (standard error)
Intercept	-0.077 (0.049)
Reading test	0.544 (0.017)
Gender (girl-boy)	0.164 (0.038)
Level 2 variance	0.112 (0.022)
Level 1 variance	0.572 (0.016)

Discussion

We have described a model-based procedure for handling quite general patterns of missingness and attrition in longitudinal data. We have used recent developments that combine existing multiple imputation techniques with procedures for transforming data to an underlying multivariate normal distribution. By considering attrition as a special case of missingness, and by assuming that auxiliary variables are available, we can set up an imputation procedure that will deal simultaneously with both attrition and item missingness. Since this procedure utilises all the available data it can be expected to provide maximum efficiency, and we have illustrated the efficiency gain with a simple example.

In longitudinal data we almost always have auxiliary data that can be conditioned upon and which is collected at the first measurement occasion. In addition, other data such as interviewer characteristics may also be available. This suggests that particular attention should be given to collecting auxiliary data that may be potentially associated with the propensity to be lost to a study, even if it is not intended to use such data in the substantive analyses. In terms of study resource allocation it could even be more efficient to devote resources to the collection of such data at the expense of attempts to secure repeated cooperation, at least where such attempts have low chances of success.

In the case of attrition, since the imputation procedure is Bayesian, we can also envisage the incorporation of prior information about missing data. For each individual, for missing items, we may have a prior distribution for the unknown values and this can also be incorporated into the imputation procedure. Such prior information could come from data that have been linked, for example from administrative records. Goldstein et al (2009) discuss this under the heading of 'partially observed data'. This can be used also with those individuals suffering attrition where such information might also come from linked data sets or be available from sources that have not been incorporated already into the auxiliary variables, such as interviewer observations. In the case of attrition a possible, less direct, alternative is to formulate a prior distribution for the imputation model parameters for each non-respondent and then combine this with the data using the current respondents' parameter values (see Rubin, 2004).

One of the problems with the techniques we have explored is that they tend to be computationally time-consuming. Nevertheless, since, in principle, we need carry out the imputation step just once for all the variables that we will be using in all our analyses, this will be less of a problem since we will simply reuse the same set of completed data sets.

The analyses in this paper were carried out, as described earlier, using multiple imputation commands newly available in MLwiN V2.10 (Rasbash et al., 2008) linked to REALCOM (Goldstein et al., 2008).

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Development of nighttime bladder control from 4 – 9 years: association with dimensions of parent rated child maturational level, child temperament and maternal psychopathology.

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Keywords

Bedwetting; nocturnal enuresis; latent class analysis; developmental typology; prospective study; child development; ALSPAC.

Abstract

Background

This study investigates variability in acquisition of nighttime bladder control in a large, general population sample of children by defining a developmental typology through latent class analysis. We also examined the association of bedwetting classes with contributing factors in early childhood including maturational level, temperament and exposure to maternal psychopathology.

Methods

We used data from over 10,000 children from age 4-9 years from a UK population sample (Avon Longitudinal Study of Parents and Children). Mothers completed questionnaires asking about their child's bedwetting (on five occasions during the assessment period), maturational level (at 18 months), temperament (24 months), and maternal depressive / anxious psychopathology (21 months). We derived longitudinal phenotypes capturing population heterogeneity in nighttime bladder control using latent class analysis. Associations with the contributing factors were investigated using multinomial logistic regression.

Results

We identified five groups of children with different patterns of development of nighttime bladder control: 1) normative (69.9% of 10,818 sample); (2) delayed (8.4%); (3) severely delayed (9.3%); (4) persistent (8.6%), and (5) relapse (3.8%). Results indicated that developmental delay, difficult temperament traits and exposure to maternal depressive/anxious symptoms were associated with an increase in the odds of children experiencing problems either attaining nighttime bladder control or with relapse in bedwetting after a period of initial dryness.

Conclusions

Development of nighttime bladder control and onset of bedwetting problems are captured by this developmental typology approach, enabling factors that affect risk of bedwetting to be determined and targeted. Further investigation is required into contributing factors relating to individuals and their environments that are associated with difficulties attaining or maintaining nighttime continence, including neurobiological and genetic factors.

Introduction

The attainment of nighttime bladder control is an important milestone in child development. Epidemiological evidence shows that the prevalence of bedwetting decreases with age (Byrd, Weitzman, Lanphear & Auinger, 1996), with most children remaining dry throughout the night by around 4 to 6 years (Blomfield & Douglas, 1956; Oppel, Harper & Rider, 1968; Fergusson, Horwood & Shannon, 1986). However, it is not uncommon for bedwetting to persist after this age into the early years of schooling, and sometimes beyond. For example, in the UK ALSPAC cohort, 15.5% of children aged 7.5 years were reported to experience some level of bedwetting, most of whom wet 'less than once a week', while only a small proportion (2.6%) wet twice or more in any one week – the frequency required for a DSM-IV diagnosis of nocturnal enuresis (Butler, Golding and Northstone, 2005). Existing data indicate that there is considerable variability between children in their pathways to nighttime continence (Croudace, Jarvelin, Wadsworth & Jones, 2003; Fergusson, Horwood, Shannon, 1986). Such population heterogeneity in both school children and clinical (help-seeking) samples, suggests that different mechanisms and contributing factors for problems in achieving and maintaining bladder control may be operating. For some children continence may be achieved relatively easily after only a few mishaps; others achieve dry nights after a prolonged period of intermittent success and failure, and some may experience a relapse in bedwetting after previously being dry. Behind these patterns may lie clues to aetiology, neurobiological mechanisms, and possible interplay between genetic and environmental factors.

In order to understand the reasons for such wide variations in the time course for development of nighttime bladder control, it has proven useful to identify groups of children who show similar patterns in development of continence, or onset of bedwetting problems. This can be done in a variety of ways, including using simple methods such as cluster analysis to define a typology, based on characteristic features. However, in recent years more powerful new methodologies for statistical modelling of longitudinal data have been developed that are particularly suited to such research e.g. model-based clustering methods. These methods are referred to as group based trajectory models (Muthén & Muthén, 1998-2006; Nagin & Tremblay, 2005) or latent class (growth) analyses when applied to longitudinal data. For example, Croudace and colleagues (Croudace et al. 2003) studied population heterogeneity in trajectories to nighttime bladder control in the 1946 British birth cohort (the Medical Research Council National Survey of Health and Development- NSHD). Latent class and group-based trajectory modelling techniques were applied to a simple binary recoding of bedwetting reports from parents on six occasions between the ages 4 and 15 years. Models with up to five longitudinal profiles were summarised graphically and a five-class solution offered as longitudinal empirical phenotypes that provide an alternative view to traditional, cross-sectional diagnoses e.g. based on DSM. Clinical diagnoses are often not available in general population samples or birth cohorts. The latent classes described the changing patterns of nighttime bladder control during the period from 4 to 15 years defined in terms of probability of bedwetting in the past month. The most common group in the general population sample was described as having normal development of nighttime bladder control (prevalence = 84.0%). This is to be expected since the data collection on bedwetting did not start until age four, censoring the trajectories to continence of the majority of the children. The second most common group exhibited delayed acquisition of nighttime bladder control and were described as "transient" (8.7%). A small group exhibited "persistent" bedwetting (1.8%) and a slightly larger group "chronic" bedwetting (2.6%). The remaining group profile was a latent class for secondary (relapse) or "onset" enuresis i.e. bedwetting that re-emerges anew after a period of initial continence (2.9%).

An important limitation of the study by Croudace et al. (2003) was that they did not examine contributing factors for bedwetting, apart from those relating to continence behaviour. Covariates were limited to daytime wetting, bowel control, and extent or duration of toilet training. Also, no other study has been able to attempt a replication of this novel typological perspective. Ideally independent data would be available to examine the robustness of these longitudinal profiles. Additionally, it is important to extend knowledge about contributing factors relating to individuals and their environments that might delay continence milestone attainment or trigger relapses. A previous study in the ALSPAC cohort (Joinson et al. 2008) found an association between previously established developmental trajectories of daytime bladder and bowel control (Heron, Joinson, Croudace & von Gontard, 2008) and contributing factors in early childhood including developmental delay, difficult temperament and exposure to maternal psychopathology. However, the association of these contributing factors with such a typological perspective on nighttime bladder control is yet to be examined. We believe it is important to examine whether these factors are also associated with the development of nighttime bladder control because this could increase understanding of potential similarities or differences in the aetiology of daytime and nighttime wetting. Also, a typological approach would allow us to examine whether different pathways to nighttime bladder control are differentially associated with these factors.

Risk factors for bedwetting are widely believed to be multi-factorial and to involve a complex interrelationship of genetic, biological, neurological, and psychological factors. In some children, bedwetting appears to be neurodevelopmental, and associated with a fundamental deficit in brain maturation e.g. of neuronal pathways controlling micturition (Barbour, Boyd, Borland, Miller & Oppel, 1963; Jarvelin, 1989). It is believed that this neurological deficit is linked not only to bedwetting, but also to the increased likelihood of delays in language and motor skill development that have been reported in children who suffer from bedwetting (Essen & Peckham, 1976; Fergusson et al. 1986; Jarvelin, 1989; Jarvelin et al. 1991; Kawauchi et al. 2001; Touchette et al. 2005; von Gontard, Freitag, Seifen, Pukrop, & Rohling, 2006). However, another study, based on a relatively small sample comprising both healthy and pre-term children, reported no association between delayed motor and language milestones and attainment of nighttime bladder control (Largo, Molinari, von Siebenthal, & Wolfensberger, 1999). It is also possible that there is an interaction between a child's maturational level and the impact of stress on the development of bedwetting, with children who suffer developmental delays showing increased vulnerability to psychosocial stress (Jarvelin et al. 1991). Furthermore, maturational delay may increase risk for relapse (secondary enuresis) among those children who experience significant or prolonged environmental stressors.

There is also some evidence that difficult child temperament traits are associated with delays in attaining continence. Temperament differences (e.g. less adaptability and more negative mood) have been found in children who experienced problems acquiring and maintaining daytime bladder and bowel control (Joinson, et al. 2008) and in those who were reported by their parents to be difficult to toilet train (Schonwald, Sherritt, Stadtler & Bridgemohan, 2004). However, the evidence is inconsistent (Blum, Taubman & Nemeth, 2004). Difficult temperament traits and little desire to co-operate with parents may lead to problems in the toilet training process. However, to date, studies of temperament-continence relations have been restricted to daytime continence and it is yet unknown whether difficult child temperament is also associated with problems attaining nighttime bladder control.

Also known to be influential are psychosocial and environmental factors in the family, linked to stress and early adversity (Kolvin & Taunch, 1973; Douglas 1973; Fergusson, Horwood, & Shannon, 1990; Jarvelin, Moilanen, Vikevainen-Tervonen, & Huttunen, 1990; Kaffman & Elizur, 1977; MacKeith, 1968; Stein & Susser, 1967; Werry, 1967). One important form of psychosocial adversity in early childhood is exposure to maternal psychopathology. A large and expanding literature evidences the short and long-term effects of exposure to maternal depression and anxiety on child development (Cicchetti, Rogosch & Toth, 1998; Downey & Coyne, 1990; Ross & McLean, 2006; Rutter, 1989). One early study of children with enuresis and their families reported a link between bedwetting and an increased rate of psychiatric disorders in the mothers (Hallgren, 1957), but this is yet to be investigated in a population-based study. The present study, based on almost 11,000 children from a UK birth cohort, has two main aims: (1) to further examine trajectories of child development to nighttime bladder control using latent class models, and (2) to test the hypotheses that the following risk factors will be associated with an increase in odds of bedwetting in school age children: child maturation/developmental delay; difficult child temperament and exposure to maternal psychopathology.

Method

Participants

The Avon Longitudinal Study of Parents and Children (ALSPAC) is a longitudinal, population-based, birth cohort study that recruited 14,541 pregnant women resident in Bristol, formerly in the county of Avon, UK with expected dates of delivery 1st April 1991 to 31st December 1992. There were 14,062 live born children. The study protocol and the representative nature of the ALSPAC sample have been described previously (Golding, Pembrey & Jones, 2001). Further details are on the ALSPAC website: <http://www.alspac.bris.ac.uk>. Ethical approval for the study was obtained from the ALSPAC Law and Ethics Committee and the Local Research Ethics Committees. Data were collected using self-completion questionnaires sent to the mothers during pregnancy and approximately annually since the birth of the child. Direct assessments were carried out at annual research clinics from the age of 7 years.

Measures

Bedwetting: Questions relating to the child's bedwetting were asked regularly between 15 months and 9.5 years. We used data from the final five time points, where questions were phrased in such a way that the occurrence of bedwetting was considered unusual rather than normal ('How often usually does your child wet the bed at night?' as opposed to 'Is your child dry during the night?'). At 4.5 and 5.5 years the carer was asked about the frequency of the child's bedwetting: a) never; b) less than once a week; c) about once a week; d) more than once a week; e) every night. At 6.5, 7.5 and 9.5 years, options (d) and (e) were reworded and three categories formed (2-5 times a week, nearly every night and more than once a night respectively). For the purpose of the analyses, we collapsed these categories into binary variables with 'yes' (1) indicating any level of bedwetting, compared to none (0).

Child Development: Maturation/developmental level at 18 months was assessed using a questionnaire developed by ALSPAC which included items from the Denver Developmental Screening Test (Frankenburg, Dodds, Archer, Shapiro & Bresnick, 1992) comprising four domains (fine motor, $\alpha = 0.679$; gross motor, $\alpha = 0.689$; communication, $\alpha = 0.752$ and social skills, $\alpha = 0.624$). Scales were adjusted for age in weeks, then standardized (using a linear regression model and extracting the

residuals) and reversed where appropriate so that high values on all scores reflected a lower level of development.

Child temperament: The Toddler Temperament Scale (Fullard, McDevitt & Carey, 1984) was administered at 24 months to assess nine temperamental traits (activity, $\alpha = 0.593$; rhythmicity, $\alpha = 0.672$; approach, $\alpha = 0.848$; adaptability, $\alpha = 0.637$; intensity, $\alpha = 0.570$; mood, $\alpha = 0.672$; persistence, $\alpha = 0.711$; distractibility, $\alpha = 0.712$, and threshold, $\alpha = 0.517$). Scales were standardised, and reversed where appropriate so that high values on all scores reflected a more difficult temperament.

Maternal psychopathology: Maternal symptoms (anxiety and depression) were assessed when the study child was 21 months using 10 questions from the Edinburgh Postnatal Depression Scale ($\alpha = 0.867$; EPDS; Cox, Holden & Sagovsky, 1987) together with the Crown-Crisp Experiential Index (previously known as the Middlesex Hospital Questionnaire) comprising anxiety ($\alpha = 0.771$); depression ($\alpha = 0.706$), and somatic symptoms ($\alpha = 0.524$) scales (CCEI; Crown & Crisp, 1979; Crown, Duncan & Howell, 1970). EPDS was dichotomized at a cut-off of 12/13, the standard cut-off used to indicate probable depressive disorder (Evans, Heron, Francomb, Oke & Golding, 2001). All CCEI scales were highly skewed and hence were dichotomized. CCEI does not have a standard cut-off so the following were used: depression scale – 8/9, anxiety scale – 8/9, somatic symptoms scale – 5/6. This ensured approximately 10% of cases fell above the cut-off, creating a group comparable in size to the EPDS group allowing easier comparison of regression estimates between the anxiety/depression measures. Further information on the child development, temperament and maternal psychopathology measures used in this study can be found in Joinson et al. 2008 – see supplementary data.

Statistical modelling

Repeated enuresis outcomes (binary) were modelled using latent variables in Mplus. The risk set eligible for these analyses consisted of 13,793 cohort members: 7,217 boys and 6,756 girls who were alive at 1 year of age. We identified the enuresis trajectories using a two-stage approach.

First, we estimated the trajectory groups using Longitudinal Latent Class Analysis (LLCA) then we compared and confirmed the results in Mplus Version 4.2 (Muthén & Muthén, 1998-2006) and Latent GOLD 4.0 (Statistical Innovations, Inc., Belmont, MA). For the latent class analysis of nighttime bladder control, at least one parental report on whether their child wet the bed at night was required and available for 10,818 children. A complete set of parental report data i.e. from all five measurement occasions was available for 5,843 children.

Secondly, we used multinomial logistic regression in Stata Version 9.2 to examine the impact of categorical, grouped and continuous risk factors on the class membership probabilities (vulnerability factors). More details of the various stages of the modelling process are given below.

Stage 1: Estimation of trajectories: Longitudinal Latent Class Analysis (LLCA) is simply latent class analysis (LCA) applied to longitudinal data. As with the standard LCA model, there are unconditional probabilities that capture the class sizes in the latent typological classification, and a set of conditional probabilities, for each time-point in each class, that describe the trajectories of bedwetting in each group. Croudace et al. (2003) employed two types of model – longitudinal latent class analysis (LLCA) and latent class growth analysis (LCGA). Although the LCGA approach is more parsimonious, capturing curvilinear trends within class profiles and allowing restrictions on the shape of the outcome trajectories (polynomial trends on the logit-linear scale), LLCA was preferred because LCGA was unable to fit the shape of the bedwetting relapse class found in their dataset where there is a turning point. For further technical details see methods in Croudace et al. (2003) and appendix therein.

In the current study, we considered only the LLCA approach since we expected to recover similar trajectory shapes and were interested in replicating the analyses from this earlier cohort. For the same reason of replication we did not consider other models such as a growth mixture model, which had not been considered in the original paper, neither did we investigate the effect of frequency of bedwetting with the LLCA. There is robustness and simplicity in our binary repeated measures analysis since it is entirely semi-parametric.

Model selection and assessment of model fit: All models were estimated using ML in Mplus 4.2 and we checked results against the log-likelihood achieved for the same model estimated in Latent GOLD 4. In both programs we used multiple random starts to help achieve the optimal maximum likelihood solution.

In order to select the 'optimal' model, we employed a number of different criteria. Statistics derived from the likelihood were considered: (i) the bootstrap p-values for the global likelihood ratio goodness of fit chi-square and (ii) the nested LR test p-values (based on bootstrap), both from Latent GOLD, in conjunction with (iii) the BLRT (Bootstrap Likelihood Ratio Test) (Nylund, Asparouhov, & Muthen 2007) and (iv) the BIC (Bayesian Information Criterion) (Schwarz, 1978) from Mplus. Finally, an assessment of model classification (v) Entropy, was also inspected (Ramaswamy, DeSabro, Reibstein, & Robinson, 1993). This is a single measure of the separation of the classes based on the posterior class membership probabilities. In addition, rather than basing the decision solely on statistical criteria, there are other aspects that should be considered including face validity, the resemblance to other results in the literature, as well as the diminishing returns of adding additional classes.

Stage 2: Multinomial modelling of contributing factors and bedwetting trajectories: Once the optimal LLCA model had been established, we used a variable representing trajectory group membership as the outcome in an examination of the contributing factors that might distinguish between normal and atypical development of nighttime bladder control. This was achieved using a set of multinomial regression models in which the odds ratios were estimated free of any constraints (mlogit) and derived in relation to the normative trajectory group, which was used as the reference group in all analyses of contributing factor associations.

In the two-stage approach (class derivation followed by covariate modelling) followed here, a non-weighted multinomial analysis using an outcome derived from modal class assignment is sub-optimal, as any uncertainty in class membership is ignored. Consequently, we reshaped the dataset so that there were five data points for each child, indicating the posterior probability assignment to each latent class. We then used the posterior probabilities as a weighting variable using Stata's `iweight` subcommand. For example, if a particular child was assigned a probability of 0.6 for class 1 and 0.1 for the four remaining classes, then the class 1 observation would be given six times the weight in the analysis. Bootstrapping was employed during preliminary work to sample from each child's distribution of posterior probabilities and this demonstrated that standard errors obtained using the `iweights` approach was accurate (details available on request).

Adjustment for confounders: We adjusted regression estimates for gender and a number of indicators of socio-demographic level that were recorded from information available during the first two years of the study child's life. This information enabled simple definitions for binary and nominal covariates for early parenthood, housing adequacy, maternal education, financial difficulties, family size, partner support, and the presence of an emotional support network. Finally, we note that further adjustment was made for intellectual disability (IQ<70) obtained from assessment at a research clinic the children attended at eight years, using the Wechsler Intelligence Scale for Children Third Edition- WISC-III; Wechsler, Golombok & Rust, 1992) due to the possibility that low IQ may be associated with both delayed attainment of nighttime continence as well as with the early childhood contributing factors detailed above. In a previous paper (Joinson et al. 2008) we carried out both methods (adjusting and excluding) due to the possibility that any of the observed associations were being driven by the low IQ subgroup. Due to the small size of the excluded group (n=114), the class distributions across the sample as a whole remained unaffected by this exclusion and the effect on the regression estimates of removing these children was negligible. We, therefore, decided that adjusting for IQ<70 would be appropriate in the current paper, because we did not expect any major changes in the results if these children were excluded. We did not take account of prescribed medicines (e.g. those prescribed for behaviour problems) because this comprised a very small number of children and is unlikely to affect the results.

Results

The risk set eligible for these analyses consisted of 13,793 cohort members: 7,217 boys and 6,756 girls who were still alive at 1 year of age. For the latent class analysis of nighttime bladder control, at least one parental report on whether their child wet the bed at night was required and available for 10,818 children. A complete set of parental report data i.e. from all five measurement occasions was available for 5,843 children.

The marginal prevalence of bedwetting outcomes and missing data at each age is shown in Table 1. Percentages refer to children who wet the bed as a proportion of the responding sample. The prevalence of bedwetting declined at each age from 30% at 4.5 years to 9.7% at 9.5 years of age. Rates for boys were higher across the full five-year observation period and level of non-response increases steadily as the child ages.

Table 1. The marginal prevalence and percentage missing data

	4.5 years	5.5 years	6.5 years	7.5 years	9.5 years
Boys (n=7217)					
No bedwetting	3139	3309	3293	3370	3414
Bedwetting	1793 (36.4%)	1281 (27.9%)	1061 (24.4%)	844 (20.0%)	526 (13.4%)
No response	2285	2627	2863	3003	3277
Girls (n=6756)					
No bedwetting	3555	3635	3516	3560	3587
Bedwetting	1074 (23.2%)	691 (16.0%)	586 (14.3%)	420 (10.6%)	225 (5.9%)
No response	2127	2430	2654	2776	2944

Deriving the nighttime bladder control trajectory classes:

Model fit statistics for three, four and five-class models fitted on complete and partially missing datasets are shown in Table 2.

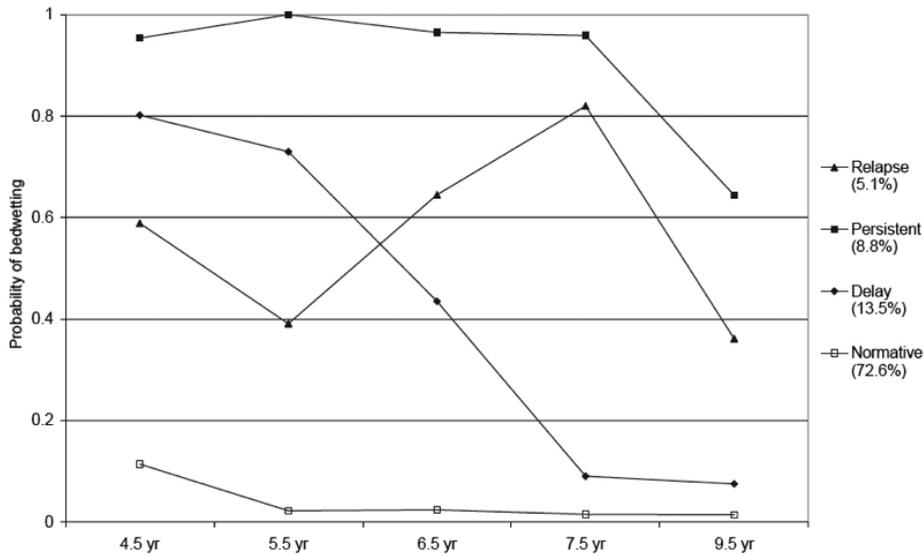
Table 2. Model fit statistics for longitudinal latent class analysis (LLCA) three, four and five-class models fitted on complete (N=5,843) and partially complete (N=10,818) samples.

	Complete case analyses			Models with partially missing data		
	3 class	4 class	5 class	3 class	4 class	5 class
Latent GOLD BS (Global)	<0.0001	0.2124	0.4788	<0.0001	0.0088	0.0152
Latent GOLD BS (Nested)*	<0.0001	<0.0001	0.1424	<0.0001	<0.0001	0.1148
Mplus BLRT*	<0.0001	<0.0001	0.1700	<0.0001	<0.0001	0.2200
Mplus BIC	20548.0	20505.7	20548.9	31833.3	31788.3	31835.7
Mplus Entropy	0.824	0.844	0.804	0.760	0.782	0.755

*Results compare current model to one with one less class

Whilst BIC (Bayesian Information Criterion) and entropy favoured the 4-class model, and the BLRT showed that the 5-class model did not significantly improve on the fit of the 4-class model, the bootstrap tests obtained via Latent GOLD suggested that the 5-class model was marginally better. We decided that both 4- and 5-class models were supported by these data and should be considered. Entropy values were high for the complete-case models, and lower but acceptable for the models with partially missing data. Trajectory shapes for the 4-class model are shown in Figure 1.

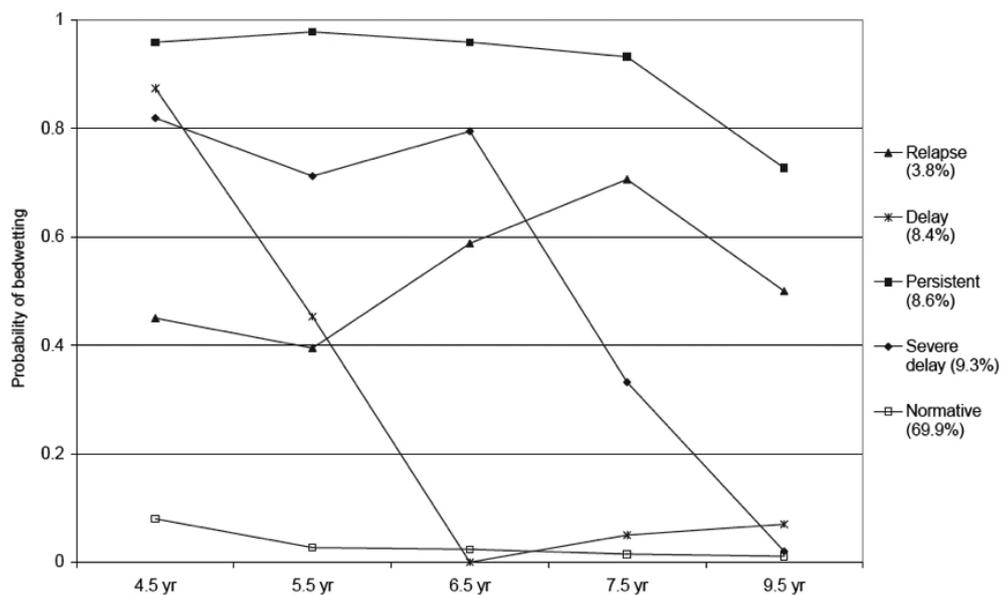
Figure 1. Longitudinal bedwetting patterns for the 4-class model, complete case sample (n=5,843).



According to the 4-class model, the prevalence of normative development of nighttime bladder control was 72.6% in children whose parents had reported on all five measurement occasions. The next largest class (prevalence 13.5%) experienced a delay in attaining nighttime bladder control, and a smaller class (prevalence 8.8%) experienced persistent problems into later childhood. The fourth and smallest class (prevalence 5.1%) attained nighttime bladder control later than the normative class, and were prone to relapse i.e. had onset of a problem after partial success in attaining nighttime bladder control.

Extraction of a fifth trajectory class in the enlarged sample (including children with some missing data) resulted in further refinement of the perspective of the mixture model on population heterogeneity – Figure 2. Here the normative development class was reduced in size due to the identification of a second delayed class: one that followed a trajectory more similar to normative development than the delayed class from the 4-class model (8.4%) and one that was similar to the group with persistent problems (9.3%). The prevalence of the persistent group remained around one in ten children (8.6%).

Figure 2. Longitudinal bedwetting patterns for the 5-class model, partially missing sample (n=10,818).



We favoured the five-class model obtained with the partially missing sample (n = 10,818) over the four-class model because of the resemblance to the findings of Croudace et al. (2003) who argued that the bedwetting trajectories they identified were consistent with current diagnostic conceptualizations of primary and secondary enuresis. The labels assigned to the five classes were as follows: (1) normative (69.9% of 10,818 sample): a class with a very low probability of a bedwetting event throughout the time period; (2) delayed (8.4%): a class with a high probability of bedwetting at 4.5 years falling quickly to a very low probability from 6.5 years onwards; (3) severely delayed (9.3%): a class with a high probability of bedwetting until 6.5 years, which then begins to diminish; (4) the persistent class (8.6%) have a very high probability of bedwetting throughout the time period, and finally (5) the relapse class (3.8%) have an initially decreasing probability of bedwetting but with a secondary peak at 7.5 years, after which the probability of bedwetting decreases. The naming convention for the bedwetting trajectories used by Croudace et al. (2003) was not adopted in the current study to make this work consistent with a previous study of trajectories of daytime wetting and soiling in the ALSPAC cohort (Heron et al. 2008).

Gender differences and rates of bedwetting at DSM-IV frequency: The prevalence varied by gender with a disproportionately high number of boys present in all non-normative trajectory classes (Table 3). These figures were derived following assignment of each child to their modal class, i.e. the class for which their posterior probability was greatest. The gender ratio was highest in the persistent and relapse classes where boys out-numbered girls by 2.10:1 and 2.13:1 respectively. Although these trajectories were derived whilst ignoring the frequency of the reported bedwetting events, the second half of Table 3 shows that there is a strong relationship between the grouping and the frequency of bedwetting, with the rates of bedwetting twice or more per week (frequency required for DSM-IV diagnosis) being much higher within the persistent wetting group and very low among the relapsing children.

Table 3. Gender ratios within class and the rates of bedwetting twice or more per week

Latent Class	1	2	3	4	5
Class Label	Normative	Delayed	Severe delay	Persistent	Relapse
Boys	47.4%	58.0%	62.9%	67.7%	68.1%
Girls	52.6%	42.0%	37.1%	32.3%	31.9%
Gender ratio	0.90	1.38	1.70	2.10	2.13
Rates of bedwetting twice or more per week					
4.5 years	1.1%	20.8%	23.3%	35.0%	4.4%
5.5 years	0.1%	8.0%	14.2%	30.1%	2.7%
6.5 years	0.0%	0.0%	6.0%	23.0%	3.3%
7.5 years	0.0%	0.0%	1.4%	16.6%	2.7%
9.5 years	0.0%	0.2%	0.0%	8.6%	3.3%

Multinomial modelling of the bedwetting trajectories and early life contributing factors

The covariates described earlier were used in a set of multinomial logistic models to assess the odds of a child belonging to each of the atypical classes. Since the model fit criteria, trajectory shapes and class distributions were very consistent for the complete case and partially missing samples, this analysis focused on the results from the larger sample. Incorporation of predictor variables resulted in a 10-15% reduction in sample size (individual sample sizes are stated within tables 4a to 4c). Previous work (Butler & Heron, 2008) has shown that there is little evidence of a relationship between bedwetting and predictors of ‘missingness’ so we felt that the reduction in sample size would have little influence on the overall findings. We fitted the models on samples where there were trajectory outcomes (derived from partially missing bedwetting data) in addition to data available on each individual contributing factor and confounders.

Tables 4a to 4c show the results of the multinomial models of the association between the contributing factors (development; temperament; exposure to maternal depression and anxiety) and the different trajectories of nighttime bladder control (delayed, severe delay, persistent and relapse). The tables show both unadjusted and adjusted odds ratios and 95% confidence intervals (models adjusted for gender, IQ<70 and indices of social adversity - including items on early parenthood, housing adequacy, maternal education, financial difficulties, family size, partner support, and the presence of an emotional support network). Odds ratios were derived in relation to the normative trajectory of nighttime bladder control (used as the reference group). For continuous contributing factors (development and temperament), regression estimates are for a 1 SD increase in the covariate. P-values shown are for a global test of differences across the five outcome groups i.e. the null hypothesis is that all four odds ratios shown are equal to unity.

Delayed, severely delayed and persistent bedwetting trajectories

Child development: Table 4a shows strong evidence for an effect in all domains of developmental level ($p < 0.001$ throughout for the unadjusted models). There is an apparent trend in odds ratios across the delayed, severely delayed and persistent bedwetting groups. For example, in the unadjusted model, there was a 14% increased odds of following a delayed bedwetting trajectory for each SD change in the total development score, whereas the percentage increased risks for the severely delayed and persistent groups were 22% and 29% respectively. Restricted models were fitted to examine whether it was possible to assume a linear relationship through these 4 outcome levels (normative/delayed/severely-delayed/persistent) whilst estimating an additional estimate for the relapse group. Chi-square values ($-2 \times$ change in likelihood) along with p-values were as follows: fine motor ($\chi^2 < 0.01$, $p = 0.996$), gross motor ($\chi^2 = 0.06$, $p = 0.814$), communication ($\chi^2 < 0.01$, $p = 0.984$), social skills ($\chi^2 = 0.13$, $p = 0.715$) and total development ($\chi^2 = 0.01$, $p = 0.942$) i.e. in support of the linear trend for these groups. Adjustment for confounders led to considerable attenuation of these effects (particularly due to gender differences), however there was still strong evidence for an association with communication, gross motor skills, social skills and total development.

Table 4a. Association of trajectories of nighttime bladder control with domains of developmental level – odds ratios for a one standard deviation drop in age-adjusted development scores.

	n	Delayed	Severe delay	Persistent	Relapse	p
Fine motor						
Unadjusted OR	9626	1.05 [0.99,1.10]	1.09 [1.04,1.15]	1.14 [1.08,1.21]	1.07 [1.01,1.14]	<0.001
Adjusted OR	9103	1.02 [0.96,1.08]	1.06 [1.01,1.12]	1.09 [1.02,1.17]	1.03 [0.96,1.10]	0.040
Gross motor						
Unadjusted OR	9622	1.08 [1.02,1.13]	1.10 [1.05,1.16]	1.15 [1.09,1.22]	1.10 [1.04,1.16]	<0.001
Adjusted OR	9100	1.08 [1.02,1.14]	1.11 [1.05,1.17]	1.16 [1.09,1.23]	1.10 [1.04,1.17]	<0.001
Communication						
Unadjusted OR	9633	1.11 [1.06,1.17]	1.19 [1.13,1.25]	1.26 [1.19,1.35]	1.17 [1.10,1.25]	<0.001
Adjusted OR	9109	1.05 [1.00,1.11]	1.11 [1.05,1.18]	1.15 [1.07,1.23]	1.09 [1.01,1.17]	<0.001
Social						
Unadjusted OR	9624	1.14 [1.09,1.20]	1.19 [1.13,1.26]	1.21 [1.14,1.29]	1.13 [1.06,1.20]	<0.001
Adjusted OR	9101	1.11 [1.05,1.17]	1.14 [1.08,1.21]	1.14 [1.06,1.22]	1.07 [0.99,1.14]	<0.001
Total development						
Unadjusted OR	9608	1.14 [1.09,1.20]	1.22 [1.16,1.28]	1.29 [1.21,1.37]	1.18 [1.11,1.25]	<0.001
Adjusted OR	9087	1.10 [1.04,1.16]	1.16 [1.10,1.23]	1.20 [1.12,1.28]	1.11 [1.03,1.18]	<0.001

Estimates for each atypical class of the outcome are referenced against the normative class.

Child temperament: Table 4b shows evidence for associations between several child temperament domains and the atypical trajectories of nighttime bladder control. In particular, there was evidence for an effect in the temperament domains of activity, adaptability, intensity, mood, persistence, and threshold. There was an increase in odds across the delayed, severely delayed and persistent bedwetting groups, with the exception of the activity domain where the odds were similar across the trajectories. Once again the assumption of a trend across certain outcome levels was upheld within these models. The only outcome for which the change in likelihood was moderately large was for mood with a chi2 of 0.60 ($p = 0.441$) providing little evidence for a deviation from a linear relationship. Following adjustment for confounders there was still evidence for associations within the temperament domains (with the exception of the threshold domain where the odds ratios were considerably weakened).

Table 4b. Association of trajectories of nighttime bladder control with temperament traits - odds ratios for a one standard deviation increase in difficult temperament scores.

	n	Delayed	Severe delay	Persistent	Relapse	p
Activity						
Unadjusted OR	9580	1.11 [1.05,1.16]	1.14 [1.08,1.20]	1.12 [1.05,1.19]	1.13 [1.06,1.20]	<0.001
Adjusted OR	9079	1.08 [1.02,1.14]	1.11 [1.05,1.17]	1.08 [1.01,1.16]	1.10 [1.03,1.18]	<0.001
Rhythmicity						
Unadjusted OR	9577	1.01 [0.96,1.07]	1.03 [0.97,1.08]	1.03 [0.97,1.10]	0.98 [0.92,1.05]	0.708
Adjusted OR	9077	1.01 [0.96,1.07]	1.04 [0.98,1.09]	1.03 [0.97,1.10]	0.99 [0.92,1.06]	0.596
Approach						
Unadjusted OR	9577	0.97 [0.92,1.02]	0.97 [0.91,1.02]	0.99 [0.93,1.06]	0.95 [0.89,1.01]	0.420
Adjusted OR	9077	0.98 [0.93,1.03]	0.99 [0.93,1.04]	1.02 [0.95,1.09]	0.99 [0.93,1.06]	0.868
Adaptability						
Unadjusted OR	9539	1.15 [1.09,1.20]	1.17 [1.11,1.24]	1.23 [1.16,1.31]	1.18 [1.11,1.26]	<0.001
Adjusted OR	9045	1.12 [1.06,1.18]	1.15 [1.09,1.22]	1.19 [1.11,1.27]	1.16 [1.09,1.25]	<0.001
Intensity						
Unadjusted OR	9574	1.07 [1.01,1.12]	1.12 [1.06,1.18]	1.15 [1.08,1.23]	1.15 [1.07,1.23]	<0.001
Adjusted OR	9075	1.05 [1.00,1.11]	1.11 [1.05,1.17]	1.14 [1.06,1.21]	1.14 [1.06,1.22]	<0.001
Mood						
Unadjusted OR	9580	1.13 [1.08,1.19]	1.12 [1.06,1.18]	1.18 [1.11,1.26]	1.14 [1.07,1.21]	<0.001
Adjusted OR	9080	1.12 [1.06,1.18]	1.12 [1.06,1.18]	1.17 [1.10,1.25]	1.15 [1.08,1.22]	<0.001
Persistence						
Unadjusted OR	9572	1.12 [1.06,1.18]	1.15 [1.09,1.21]	1.18 [1.11,1.25]	1.17 [1.10,1.25]	<0.001
Adjusted OR	9075	1.10 [1.05,1.16]	1.14 [1.07,1.20]	1.14 [1.07,1.22]	1.15 [1.07,1.23]	<0.001
Distractibility						
Unadjusted OR	9577	1.01 [0.96,1.06]	1.04 [0.99,1.10]	1.09 [1.02,1.16]	1.01 [0.94,1.07]	0.081
Adjusted OR	9077	1.00 [0.95,1.05]	1.02 [0.96,1.07]	1.06 [0.99,1.13]	0.99 [0.92,1.06]	0.464
Threshold						
Unadjusted OR	9581	1.07 [1.02,1.12]	1.07 [1.02,1.13]	1.12 [1.06,1.19]	1.08 [1.02,1.15]	<0.001
Adjusted OR	9081	1.04 [0.99,1.10]	1.03 [0.97,1.08]	1.05 [0.98,1.11]	1.04 [0.97,1.10]	0.372

Estimates for each atypical class of the outcome are referenced against the normative class.

Maternal psychopathology: For the maternal depression/anxiety measures, there was evidence for an effect in three of the domains (EPDS depression; CCEI anxiety; CCEI depression) (Table 4c). Trends across the delayed, severely delayed and persistent groups were less apparent for the maternal depression/anxiety measures and there was little evidence for ranking between the severe delay and persistent groups. Although it appeared that a linear effect would not adequately describe the relationship shown in these results, examination of changes in likelihood provided little evidence for a deviation from a linear relationship: EPDS ($\chi^2 = 0.60$, $p = 0.441$), anxiety ($\chi^2 = 0.01$, $p = 0.940$), depression ($\chi^2 = 0.90$, $p = 0.342$), somatic symptoms ($\chi^2 = 0.61$, $p = 0.435$).

Table 4c. Association of trajectories of nighttime bladder control with maternal depression and anxiety measures - odds ratios for scores above the cut-offs on the Edinburgh Post Natal Depression Scale and the Crown Crisp Experiential Index scales for depression, anxiety and somatic symptoms.

	n	Delayed	Severe delay	Persistent	Relapse	p
Edinburgh Post Natal Depression Scale (EPDS)						
Unadjusted OR	9452	1.01 [0.85,1.20]	1.30 [1.10,1.55]	1.37 [1.12,1.67]	1.36 [1.11,1.68]	<0.001
Adjusted OR	9093	0.96 [0.79,1.15]	1.30 [1.08,1.57]	1.23 [0.99,1.53]	1.27 [1.02,1.59]	0.008
Crown Crisp Experiential Index (CCEI) anxiety score						
Unadjusted OR	9327	1.09 [0.92,1.29]	1.21 [1.02,1.43]	1.31 [1.07,1.59]	1.37 [1.12,1.67]	0.003
Adjusted OR	8981	1.07 [0.89,1.28]	1.23 [1.02,1.47]	1.24 [1.00,1.53]	1.35 [1.09,1.68]	0.016
CCEI depression score						
Unadjusted OR	9394	1.01 [0.84,1.21]	1.35 [1.12,1.62]	1.38 [1.12,1.70]	1.26 [1.02,1.56]	<0.001
Adjusted OR	9044	0.97 [0.80,1.19]	1.38 [1.14,1.69]	1.27 [1.01,1.61]	1.21 [0.97,1.52]	0.004
CCEI somatic score						
Unadjusted OR	9410	1.03 [0.86,1.22]	1.02 [0.85,1.22]	1.28 [1.04,1.57]	1.23 [0.99,1.53]	0.087
Adjusted OR	9055	0.99 [0.82,1.20]	0.97 [0.80,1.17]	1.13 [0.91,1.41]	1.18 [0.93,1.50]	0.487

Estimates for each atypical class of the outcome are referenced against the normative class. EPDS depression score above a cut-off of 12/13; CCEI scale scores above the following cut-offs: depression – 8/9, anxiety – 8/9, somatic symptoms – 5/6.

Bedwetting relapse trajectory: There was also evidence for an association between some of the early life contributing factors and the trajectory that represents relapse in bedwetting. For each SD change in the domains of developmental level, there was a 7-18% increased odds of following a bedwetting relapse trajectory, with similar odds for the temperament domains of activity, adaptability, intensity, mood, persistence, and threshold. However, for the maternal depression/anxiety measures, the association was stronger, with a 23-37% increased odds of following a bedwetting relapse trajectory for each SD change in each depression/anxiety domain.

Co-morbidity with daytime wetting and soiling: Previous results (Joinson et al. 2008) have shown a strong relationship between the contributing factors considered here and trajectories of both daytime wetting and soiling. It was surprising to see that to a large extent the results discussed in the current manuscript mirror those already reported. Due to the well-established association between bedwetting and daytime wetting/soiling (von Gontard & Hollmann, 2004), it was considered important to ascertain whether the results reported above were being driven by this co-morbidity. Consequently, the results were further adjusted for membership of both atypical daytime wetting and soiling trajectory classes (results not shown but available from corresponding author). As expected, there was a further reduction in the odds ratios associated with the early life contributing factors, however, there was still evidence for an association with many of the factors considered. This suggests that the association between the bedwetting trajectories and the contributing factors cannot be fully explained by the association between the contributing factors and daytime wetting/soiling. There is still evidence for an

association between the contributing factors and problems attaining (or maintaining) nighttime continence. This is even after taking into account that these contributing factors are also associated with daytime continence problems that often co-occur with bedwetting.

Discussion

This study based on a large UK birth cohort, applied latent class models to longitudinal data comprising parental reports of bedwetting from 4 - 9 years. Children were classified with respect to delay in attainment of nighttime bladder control, persistence of bedwetting, and secondary onset or relapse in bedwetting. Variations in normal development, occurring before the first measurement of problem wetting were not modelled, and hence a morbidity-oriented approach is adopted, that conforms closely to that applied by Croudace et al. (2003). Having established this congruence, the study then examined variation in membership probabilities for these empirically based, bedwetting classes by three key early life risks. All contributing factors related to characteristics of the child (maternal reports of maturation/developmental level at 18 months and child temperament traits at 24 months) or the mother (self-reported maternal anxious and depressive psychopathology experienced when the child was around 21 months old).

Using a larger and more recent cohort of UK children, but employing the same group-based (latent class) analytical approach the current study results presented four and five class models with similar profiles to those reported by the Croudace et al. (2003) typology. It is extremely rare for complex statistical models hypothesizing population heterogeneity to be tested on almost identical data in more than one sample with similar high quality prospective data; this is particularly the case when the questions of interest concern developmental outcomes for thousands of children, representative of the population in a defined geographical area.

The current study extended previous work by examining the associations between the contributing factors in early childhood and the developmental trajectories of nighttime bladder control. Of the three areas of risk considered, all were shown to be associated with problems attaining or maintaining continence, consistent with our hypotheses.

Child Development

Children who were reported by their parents to have developmental delays at 18 months had increased odds of bedwetting at school age, with a trend for increasing odds ratios across the delayed, severely delayed and persistent bedwetting groups. Bedwetting has been previously described as a genetically determined maturational disorder of the CNS (von Gontard, Schmelzer, Seifen, & Pukrop, 2001) and this is supported by studies reporting evidence that developmental immaturity may play a part in the aetiology of bedwetting (Essen & Peckham, 1976; Fergusson et al. 1986; Jarvelin, 1989; Jarvelin et al. 1991; Kawauchi et al. 2001; Touchette et al. 2005; von Gontard et al. 2006). A recent study, finding differences in intellectual capacities between children with and without bedwetting in the ALSPAC cohort, also underlines the importance of neurological factors (Joinson et al. 2007a). The specific factors relating to the CNS include polyuria (Rittig, Knudsen, Norgaard, Pedersen, & Djurhuus, 1989), lack of arousal (Wolfish, Pivik & Busby, 1997) and failure to inhibit the micturition reflex during sleep (Ornitz et al. 1999; Koff, 1996). The first mechanism is mediated by antidiuretic hormone secreted from the CNS, whilst the latter two mechanisms are mediated by the brainstem. The increased odds of maturational/developmental delays in children with bedwetting in the current study (particularly those with persistent bedwetting) are likely to be a manifestation of an underlying neurological deficit that is also linked to the inability to control nighttime micturition.

There was also some evidence for an association between developmental delay and relapse in bedwetting (although the odds ratios were smaller), suggesting a common underlying aetiology for primary and secondary (relapse) bedwetting. This view is supported by Fergusson et al. (1990) and Jarvelin (1989) who argue that both primary (never achieved nighttime bladder control for at least six consecutive months) and secondary enuresis (achieved nighttime bladder control for at least six months, and then suffers a relapse in bedwetting) are aspects of the same problem and share a common aetiological basis. They suggest that primary enuresis is due to delayed maturation of the physiological mechanisms controlling nighttime micturition and that, in the case of children who

achieve nighttime bladder control and then experience relapse, this could be due to an underlying susceptibility to bedwetting provoked by stressful experiences.

Child temperament

This is the first study that we are aware of to investigate the association between bedwetting and early child temperament. There was evidence for more difficult temperament traits, rated by parents at 24 months, in children with delayed acquisition of nocturnal bladder control, persistent bedwetting and relapse in bedwetting. Children who were bedwetting between the ages of four and nine years were more likely at 24 months to be reported by mothers to have a higher activity level (e.g. fidgeting during quiet activities); were less adaptable (e.g. less likely to be coaxed out of a forbidden activity); had a higher intensity level i.e. more intense emotional reactions (e.g. screams or yells when frustrated); were more negative in mood (e.g. fretting or crying when learning a new task), and had lower levels of persistence i.e. were more easily frustrated and likely to give up activities (e.g. routine tasks such as dressing and picking up toys). These findings are supported by earlier studies describing certain 'personality features' of children with enuresis, including more irritability and less compliance (Moilanen, Järvelin, Vikevaainen-Tervonen, & Huntunen, 1987) and lower patience and tolerance, more difficulties with concentration, and inappropriate behaviour (Srivastava, Nigam & Sing, 1982).

Early difficult temperament has been found to be related to the development of externalizing and internalizing problems later on in childhood (Muris & Ollendick, 2005; Oldehinkel, Hartman, De Winter, Veenstra & Ormel, 2004). Moreover, there is evidence that bedwetting is associated with externalizing and internalizing problems in school age children in the ALSPAC cohort (Joinson, Heron, Emond & Butler, 2007b), suggesting that early difficult temperament traits could be precursors to these later problems. In particular, co-morbidity between bedwetting and attention and activity problems has been widely reported (Baeyens, Roeyers, Van Erdeghem, Hoebeke & Vande Walle, 2007; Joinson et al. 2007b). It is particularly notable that the odds ratios for the temperament trait of higher activity were similar across the trajectories, in comparison to the findings for the other temperament traits, where there was a general increase in odds across the delayed, severely delayed and persistent bedwetting groups. The link between higher activity levels reported in children at 24 months and subsequent bedwetting at school age could be due to a common underlying neurological deficit in the basic inhibitory function of the brainstem that also leads to an inability to inhibit the micturition reflex during sleep.

Another possible mechanism through which child temperament may impact on the development of nighttime bladder control is through parents having more negative perceptions of a child who has difficult temperament. Parents who rated their child as having difficult temperament at age 2 years may have been more likely to attribute subsequent bedwetting to the child's difficult behaviour or lack of co-operation with their attempts to encourage nighttime bladder control. Such negative reactions could have led to anxiety and stress, which have been shown to be associated with problems attaining nighttime bladder control (Houts, 1991). Some support for this argument comes from a finding in the ALSPAC cohort that parents of children who were still wetting the bed at age seven were more likely to report that they had shown displeasure at their child's bedwetting in the past compared to parents of children who were dry at night (Butler, Golding & Northstone, 2005). It is not uncommon for parents to become intolerant of their child's bedwetting and resort to punitive actions, especially if they believe that the child is to blame (Butler, Redfern & Forsyth, 1993).

Maternal psychopathology

The current study found an association between bedwetting (particularly the severely delayed and persistent bedwetting group) and maternal self-reported anxiety and depressive symptoms experienced when the child was around 21 months old. These findings are supported by evidence from an early clinical study reporting that bedwetting is associated with an increased rate of psychiatric disorder in the mother (Hallgren, 1957). Mothers with depression and/or anxiety are more likely to be hostile and irritable toward their child, to engage in harsh disciplining behaviours, and to be less sensitive or responsive to their child's needs (Sohr-Preston & Scaramella, 2006; McLearn, Minkovitz, Strobino, Marks, & Hou, 2006; Nicol-Harper, Harvey & Stein, 2007). It is possible that these factors could lead to an increased risk of stress or anxiety in the child. This argument is supported by evidence that children's stress hormone levels are influenced by exposure to maternal depression (Ashman, Dawson,

Panagiotides, Yamada, & Wilkinson, 2002). According to Jarvelin et al. (1990), at around two years children begin to acquire bladder continence and early stress can interfere with this process. Stress is believed to interfere with the acquisition of bladder co-ordination, leading to bladder over-activity, avoidance of waking to a full bladder, or inhibition of antidiuretic hormone (Houts, 1991). Antidiuretic hormone decreases the amount of urine produced at night, but it also has a role in modulating the response of the hypothalamic-pituitary-adrenal (HPA) axis to stress. The stress hormone cortisol exerts a negative feedback directly on the pituitary and also on the synthesis and secretion of antidiuretic hormone, a lack of which is associated with bedwetting due to the production of more urine than the bladder can hold (Aikawa, Kasahara, Uchiyama, 1998; Rittig et al. 1989).

Exposure to earlier maternal depression and anxiety was also associated with an increased risk of relapse in bedwetting among school age children, again suggesting that primary and secondary enuresis may share a common underlying aetiological basis. However, for the maternal depression/anxiety measures, the pattern of odds ratios for the relapse group in comparison to the other trajectory groups is noticeably different to that found for developmental delay and temperament. In the analysis with developmental delay and temperament, the odds ratios for the relapse group are generally smaller, or similar in magnitude to, the odds ratios for the other groups. In contrast, the adjusted odds ratios for the relapse group are the highest for two of the maternal measures - the anxiety and somatic scales of the CCEI. The stressful effects on the child of exposure to maternal anxiety or somatic symptoms during the sensitive period of learning bladder control could have led to incomplete acquisition of bladder control and increased susceptibility to bedwetting, especially during times of increased stress. It is also possible that mothers reporting experiencing these symptoms when their child was around two years old may have experienced similar symptoms during the assessment period (when their child was 4 to 9 years old) and a relapse in bedwetting at school age could also be related to the effects of proximal exposure to maternal distress and associated life events/stressors.

Limitations

A small proportion of children had still not attained nighttime bladder control by the end of the assessment period in the current study. Consequently, the prevalence of the group with persistent bedwetting was higher in the current cohort compared to the NSHD cohort, because the time span covered by the parent reports was shorter. If observed until 15 years, then the current study would have had the same time period as in the NSHD for their symptoms to remit and, through a refinement of the trajectory groups, many of the persistent cases may become more similar to the severely delayed group. As a result, we are unable to say whether the trend for an increased association of the contributing factors with increased level of bedwetting (from delayed, to severely delayed to persistent) is actually being driven by children who would be re-classified as severely delayed if the assessment period were to be extended beyond 9 years, rather than those who would remain in the persistent bedwetting group.

In the present study, frequency of bedwetting was not incorporated into the model, but instead bedwetting was treated as a binary outcome variable. This was done to simplify analysis, establish a correspondence with the NSHD analysis and data, and to facilitate graphical presentation of the results. Although we considered using the full ordinal variation in the data captured by the 6-point 'frequency of bedwetting' response scale there is elegance and simplicity in our wet versus dry outcome. In addition, an aim of this study was to show the different developmental trajectories of nighttime bladder control in a non-clinical population and not to focus on children whose bedwetting meets DSM-IV criteria. Since we used a low threshold for bedwetting (i.e. the bedwetting groups were not restricted to children who met DSM-IV criteria), the effect sizes found in this study are relatively small, but they apply to the whole range of bedwetting problems in a sample drawn from the general population. Previous studies on the ALSPAC population have shown that it is important to consider not only those children whose bedwetting meets DSM-IV criteria, but also those with less frequent bedwetting due to a number of adverse psychological outcomes in this group (Joinson et al. 2007b). Another study reported evidence for neurological impairments in children whose bedwetting did not meet DSM-IV criteria (Jarvelin et al. 1991).

It is notable that we found a strong relationship between the trajectory groups and the frequency of bedwetting, with the rates of bedwetting twice or more per week being much higher within the persistent wetting group and very low in the relapsing group. It has been suggested that persistence of

bedwetting into adolescence and beyond is more likely in children who wet the bed more than twice a week rather than those wetting less frequently (Butler & Heron, 2008; Yeung, Sreedhar, Silhoe, Sit & Lau 2006). Future studies with the ALSPAC data are planned, not only extending the trajectories of nighttime bladder control into adolescence, but also incorporating frequency of bedwetting into the longitudinal mixture model. This may help to shed light on whether children who experience frequent bedwetting that persists into late childhood and adolescence may not simply be at the end of a continuum of severity, but may represent a qualitatively distinct group with a different set of contributing factors.

Another possible limitation of this study is that it relied on maternal reports for both bedwetting and the contributing factors relating to the child and mother, thus introducing method bias as a potential explanation for the effects reported in this study. However, we do not feel that method variance is a satisfactory explanation for the effects found in this prospective data because it is highly unlikely that mothers would have invented subsequent bedwetting episodes in their children. Relying on parental reports of children's bedwetting would be potentially more of a problem if the study had examined frequency of wetting, due to the possibility that this could be under/over-estimated by parents. The use of a binary measure of bedwetting should have minimized this limitation as it is unlikely that a child's bedwetting would go entirely unnoticed by parents. It is also possible that parents of children who wet the bed may overestimate problems relating to their child, such as difficult temperament. However, the prospective design of this study means that parental reports of child temperament pre-date the reports of bedwetting problems. Mothers suffering from depression are more likely to view their child negatively (Fergusson, Lynskey & Horwood, 1993) and this is potentially more of a problem, because maternal depression (assessed when the child was 21 months) may have negatively influenced maternal reports of child temperament (assessed at 24 months).

The methods used have enabled us to dramatically simplify the complex set of responses relating to the occurrence of bedwetting observed within this cohort. We have represented the changing patterns relating to the development of nighttime bladder control of over 10,000 children as four groups with some level of communality in their progression towards continence and have then examined differences in the aetiology of these groups. This modelling approach to describing population heterogeneity is simple to understand and offers a good account of these data. A potential power of group based trajectory modelling over other methods is that it permits the statistical modelling of unobserved heterogeneity in the development of nighttime bladder control and may result in the identification of other groups not predicted by theoretical classification. Identification and analysis of distinctive developmental trajectories of nighttime bladder control is important because it may help to elucidate different risk factors relating to characteristics of individuals and their environments that account for qualitative differences across individuals in their developmental course. Although the trajectory modelling approach can often describe data very well in terms of groups, that does not imply that these groups actually exist, merely that this representation of the data is useful and appealing, especially from the point of view of prognosis and treatment. There is always scientific value in replication of the subgroups in other datasets where additional scientific scrutiny can be gained through external validation against other criteria, such as clinical diagnosis of nighttime enuresis.

Conclusions

The current study emphasizes the importance of a developmental approach to bedwetting through the examination of different pathways to the attainment of nighttime bladder control, and has broadly replicated the findings of Croudace et al. (2003). The study also examined the role of early-life contributing factors in the development of nighttime bladder control, and these findings are supported by, and also extend, previous studies of bedwetting. In particular, the association of bedwetting with maturation level has been widely reported, but this is the first study to show that there is a trend for increasing odds of developmental delay with increasing delay of nighttime bladder control. Associations between early temperament and subsequent bedwetting were also examined for the first time in this study. The link with more difficult temperament traits may relate to early indicators of externalizing or internalizing problems, shown by previous studies to be co-morbid with nocturnal enuresis. The current study also adds to the literature on the association between stress and bedwetting, showing that children exposed to maternal depressive and anxiety symptoms at around two years have an increased risk of problems attaining nighttime bladder control. Increased understanding of the contributing factors that lead to problems attaining nighttime bladder control is

essential because a significant proportion of children suffer from bedwetting into their school years, and if these problems remain unresolved or untreated they can become socially and psychologically debilitating (Butler, 2001; Issenman, Filmer & Gorski, 1999).

Important areas to consider for future research include, investigating whether the contributing factors identified in the current study anticipate children with increased vulnerability to problems with nighttime bladder control, and whether interventions targeting factors such as exposure to maternal depression, result in a decreased risk of bedwetting. Future studies should extend the age range covered in the current study, to investigate contributing factors associated with bedwetting that persists into adolescence and adulthood. A comprehensive examination of other potential contributing factors, including family history, prenatal influences, toilet training practices and life events, is also needed in order to shed light on the aetiology of this prevalent childhood problem.

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Does mothers' employment affect children's development?

Evidence from the children of the British 1970 Birth Cohort and the American NLSY79

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Abstract

Background

The increasing employment of mothers of young children in the UK and the USA is widely believed to affect children adversely. Maternity leave and part-time employment, more common in the UK than the US, are possible offsets.

Methods

This paper analyses the cognitive and behavioural development of school-aged children by maternal employment before the child's first birthday. Data come from the second generation of two cohort studies: the 1970 British Birth Cohort Study (BCS70) and the US 1979 National Longitudinal Study of Youth Child (NLSY79). Both contain several outcomes per child, in some cases several children per mother. The hierarchical structure is tackled by multi-level modelling. Each data set supplies a good array of controls for confounding variables (such as maternal education and ability, family history) which may affect labour market participation.

Results

Similar to other studies, results are mixed and modest. Only two out of five US estimates of maternal employment in the child's first year have a significant (0.05 level) coefficient on child development – negative for reading comprehension, positive for freedom from internalized behaviour problems. None of the estimates were significant for four child outcomes modelled in Britain.

Conclusions

Despite public opinion to the contrary, our study finds little evidence of harm to school-age children from maternal employment during a child's infancy, especially if employment is part-time, and in a context, such as Britain in the 1990s, where several months of maternity leave is the norm.

Keywords

Maternal employment; child outcomes; cognitive development; behavioural adjustment; maternity leave; BCS70 second generation survey; NLSY79 children and young adult survey; intergenerational transmission; full/part-time employment; US-UK comparison.

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Background and Literature Review

Childrearing and paid work, once thought to be mutually exclusive activities, are being increasingly combined in most industrial countries. In recent decades, both the United Kingdom and the United States have witnessed a substantial increase in the labour force participation of mothers with young children. In Britain during the 1970s only about 26 percent of mothers with children under 5 had paid work (Martin and Roberts, 1984). By the turn of the Millennium this figure had risen to 43 percent (figure for UK in 2001, Twomey, 2002). In the United States the number of mothers with children under age six who were in the labour force grew at a similar rate (66 percent) between 1976 and 2000, and among mothers with infants, the growth rate was 78 percent (Downs, 2003). An important question to address is whether maternal employment has costs for children. Here, however, opinion outruns evidence. With regard to public attitudes, concern that maternal employment might have negative consequences for children's development has risen, rather than abated, as mothers' employment becomes more commonplace. Attitude surveys in the UK showed a decrease between 1994 and 2002 in the percentages of both British men (from 52 to 42 percent) and British women (from 51 to 46 percent) who felt that family life would not suffer as a consequence of female employment (Scott, 2008). In the US the drop was larger still as the percentage of Americans giving such a non-traditional response fell from 51 to 38 percent over the same time period.

These figures refer to attitudes only, however. They do not reveal whether the dual responsibilities of employment and mothering are actually undertaken at the expense of child well-being. The report on The Good Childhood Inquiry in the UK concluded that the results of research to date were mixed and that more investigation was needed (Layard and Dunn, 2009, p 21). Press coverage of the Inquiry, however, (and of Scott's (2008) book) presented working mothers as one of the features of modern life that threaten the well being of children. In this paper we offer new longitudinal evidence for both the United Kingdom and the United States.

This comparison is valid as the policy context in the United Kingdom regarding the employment of new mothers contrasts with the one facing American mothers. In the United Kingdom a growing number of mothers have been covered by maternity leave and pay. Statutory rights to maternity leave were introduced in 1975. Provisions for leave became increasingly extensive over subsequent years, with growing numbers of employed pregnant women (particularly those expecting their first child) becoming eligible for seven months protected job leave, and rising numbers receiving from 12 to 16 weeks maternity pay after a birth. Although an increasing proportion of mothers return to the labour market during the first year of a child's life, their labour force re-entry is likely to be after 4-6 months of leave.

In contrast, it was not until after the implementation of the Family and Medical Leave Act of 1993 (FMLA) that mothers in the United States were statutorily entitled to any leave from employment specifically occasioned by a birth. Further, in order to be eligible for up to 12 weeks of *unpaid* leave sanctioned by this Act, employees had to have worked for at least 12 months for a company employing at least fifty workers. American mothers employed during the child's first year are likely to have started back to work within 6-12 weeks of giving birth.

Benefit regimes in the United States, additionally, reinforce early labour market entry for single mothers, whereas in the United Kingdom the income support system reflects the hitherto normative expectation that mothers should stay at home with their babies (Kilkey and Bradshaw, 1999).

In the United Kingdom, just under half of new mothers of children born in 2000-01 were employed by the time the child was nine months old (Dex et al, 2005a) whereas in the United States, one third of mothers were in the labour force before their child was three months old (Berger et al, 2005). Our present study explores whether children in the United States – who are exposed to maternal employment earlier in their infancy on average – show similar patterns of cognitive and behavioural development to their counterparts in the United Kingdom.

Theoretically, there are reasons why one might expect both benefits and negative consequences of maternal employment for later child development. Increased market work clearly provides extra income for the family and there is a vast literature establishing that children who grow up in poverty demonstrate poorer cognitive and socio-emotional outcomes later in life than their counterparts from more prosperous homes (Gregg et al, 2008). Income in the preschool years also appears to have greater impact than income in later periods (Votruba-Drzal, 2006; Duncan et al, 1998). On the other hand, early maternal employment may reduce the quality of mother-child interactions by disrupting the formation of crucial mother-child attachments – as hours spent in other forms of child care increase, or by causing maternal stress (Waldfogel, 2002).

Results from prior studies that have examined the relationship between maternal employment and later child wellbeing in either the United States or the United Kingdom suggest mixed but modest findings. Some studies show positive effects (for example, Moore and Driscoll, 1997). Results from other studies imply that the association between maternal employment in early childhood and subsequent child development differs depending on when work takes place, the nature of maternal employment and the specific child/adolescent outcomes considered (Parcel and Menaghan, 1994; Greenstein, 1995; Barglow, et al, 1998). More recent analyses suggest some negative outcomes of maternal employment, especially when mothers are in the labour force during the child's infancy (Han et al, 2001; Brooks-Gunn et al, 2002; Baum, 2003; James-Burdumy, 2005), or are employed full-time (Ermisch and Francesconi, 2002; Gregg et al, 2005). However, most results are again modest, and many appear to depend additionally on other family characteristics. For example, Wertheimer and colleagues (2008) report that increased work effort among *low-income* families resulting from welfare reform legislation introduced into the United States in 1996 is associated with better child outcomes. Ruhm (2005) also finds benefits to offspring in middle childhood from maternal employment when these children are from relatively disadvantaged backgrounds, but reductions in cognitive test scores among advantaged 10 and 11 year olds when their mothers work. In contrast, Verropoulou and Joshi (2009) find poorer reading levels among children when less educated British mothers work in their child's first year of life. In this study we extend the literature, taking new evidence from Britain, and comparing it with a parallel American dataset to address the following research questions:

- Does the employment of mothers of infants have adverse effects on children's subsequent development?
- Do the children of the American and British cohorts show different patterns, in view of different policies towards mothers' paid work in a child's early months?
- Do cognitive and behavioural outcomes differ?

The longitudinal data sets we use enable us to rule out reverse causation which may affect cross-sectional evidence, in so far as our child outcomes are measured several years after the mother's employment spell that we focus on. The richness of the data also enables us to control for some of the heterogeneous confounding factors which may mask an underlying impact of employment on child development. However, we do not claim firm evidence on causality. These are observational studies and therefore cannot provide information on counterfactual outcomes – what children might have experienced had working mothers stayed at home, or had mothers who stayed at home gone out to work.

Data and Methods

Data Sources and Attrition

We use data from the second generation of two cohort studies: the British Birth Cohort Study of 1970 (BCS70) and the 1979 American National Longitudinal Study of Youth (NLSY79). The original BCS70

sample consisted of 17185 persons born between April 5th and April 11th, 1970, of whom 8279 were female. Six waves of data have been collected to date on these British women. We use data from the most recent sweep which was carried out in 2004-05 when respondents were ages 34-35, and 5029 interviews were achieved with female members of the cohort, representing 62 per cent of those eligible to respond at that date. For a one-in-two sample of BCS70 cohort members, information was also gathered about all natural and adopted children currently living with them. A total of 2,846 parents (of which 1,725 were mothers) participated in these Parent and Child Interviews, providing information on 5,207 children (Simmonds et al, 2007). We do not consider male cohort members as the BCS70 does not record employment histories for their wives/partners, and the NLSY79 only collects information on children born to their female cohort members.

The NLSY79 is also a longitudinal study. 12,686 respondents were first interviewed in 1979 when they were ages 14-21 of whom 6283 were female. This total included a nationally representative sample plus oversamples of blacks, Hispanics, military personnel and white youth from low socioeconomic backgrounds. NLSY79 respondents have been re-interviewed annually through 1994 and biennially since, although the military and disadvantaged white oversamples were dropped in 1985 and 1990 respectively. Beginning in 1986, in-depth information was collected on and from all children born to NLSY79 women biennially. When these children turn 15 they become Young Adults and are given a different survey containing questions that more closely match those asked of their mothers at similar ages.

In 2002, more than 60 percent of NLSY79 respondents had answered all twenty surveys since 1979 and the average respondent had completed 17.2 interviews (CHRR, 2004). We use data from the 2000 survey round when the response rate for all NLSY79 cohort members still eligible for interview was more than 83 percent. Although attrition is always a problem in longitudinal studies, the NLSY79 has one of the highest retention rates of any longitudinal survey in the US. The retention rate of 83 percent after 21 years also compares favourably with 62 per cent for females in BCS70, although the latter represents 34 years of follow-up. The NLSY79 children also have exceedingly high retention rates.

Selection Bias and Sample Representativeness

Our British sample consists of 2,083 children between the ages of 4 and 16 years when assessed in 2004-05 who were born to a total of 1,235 mothers. 52.5 percent of mothers therefore had more than one child in the sample. As these mothers all belonged to a single birth cohort, they were all the same age when their children were assessed. This means that the age of each child in the second generation sample is inversely related to the age of their mother when she gave birth to them. Children over 10 were all born to mothers under age 25, and, as only children who were at least 4 years old could be assessed, all children in our sample were born before their mothers turned 30. The study design thus has a built-in focus on children of younger mothers. Appendix 1 provides information on the educational attainment and age at first birth of our UK and US sample mothers, along with equivalent information for three other groups of women: all women; all women who had ever borne a child; and all mothers with a first birth prior to 2000 (BCS70) or 1996 (NLSY79). Our BCS70 sample is comprised of relatively young mothers who have low levels of educational attainment when compared to other mothers, and especially when compared to women who were still childless at age 34-5. We know that mothers who delay childbearing into their thirties also have higher attachment to employment both before and after motherhood than their younger counterparts (Dex et al, 2005b; Kneale and Joshi, 2008). This means that any conclusions drawn from this sample of relatively young mothers and their older children may not be generalisable to those who have their children at more mainstream ages. However, these mothers are not uniformly low achievers, and we control for both maternal abilities and attainments as well as for child birth order in our analyses.

The American members of the NLSY79 who were 14-21 when first interviewed in 1979 are a little older than their British counterparts who would have only been 9 years old in 1979. We therefore confine our analyses to mothers aged 14-17 in 1979 (born 1962-65), and take our information from the 2000 wave of data collection when these mothers were 35-38 years old. Not including women in the dropped oversamples as described above, 2225 women ages 14-17 were interviewed in 1979. The percentage of mothers who were successfully interviewed in 2000 is notably higher than that of childless women. Once we further restrict our sample to women with children ages 4-14 in 2000, our total number of American children is 1,413 who were born to 840 mothers. Again about half the mothers (50.1 percent)

have more than one child in the sample. Further, older children born to older women are again underrepresented in our data, although the bias towards older children of younger mothers is less marked than in the British data, given the exclusion of children 15 and older who 'graduate' to become Young Adults. The study sample has a similar age at first birth to all mothers but a higher percentage of women who failed to obtain a high school diploma (Appendix 1).

Outcome measures

Our child outcome measures incorporate dimensions of both cognitive attainment and behaviour. Both the BCS70 and the NLSY79 include measures of reading and maths. In the BCS70, children ages 4-5 and 6-16 are assessed using age appropriate versions of the British Ability Scales (Elliott, 1996, Hill, 2005) for naming vocabulary (ages 4 and 5) reading recognition (age 6+) and maths proficiency. The Children of the NLSY79 are assessed at ages 5-14 using three subtests of the Peabody Individual Achievement Test (PIAT): mathematics, reading recognition and reading comprehension (CHRR, 2006). In each country, mothers were asked to report on their children's behavioural adjustment. Goodman's Strengths and Difficulties Questionnaire (SDQ) (Goodman, 2001) was used in Britain, and the Behavior Problems Index or BPI (Peterson and Zill, 1986) was used in the United States. Although the two behavioural indices differ, evidence suggests that they are comparable. Many items in the BPI are derived from the Achenbach Behavior Problems Checklist (Achenbach and Edelbrock, 1981) and research undertaken by Goodman and Scott (1999) showed that scores from the SDQ and the Achenbach's Behavior Checklist were highly correlated. Both data sets include similar, though not identical, scales measuring externalised and internalised behaviour. The former includes aggression, disobedience, restlessness and impulsivity. A child with internalised problems is one described as often tearful, fearful, anxious or unhappy.

For our NLSY79 sample, we summed the items that make up an existing pair of variables summarising externalised and internalised behaviour (CHRR 2006). In order to facilitate comparison across instruments and the two countries, we convert each child's developmental assessment into a percentage fraction of the highest score it would be possible to achieve on that particular scale/test. This also means that all children's scores are converted into a common metric regardless of how many individual items they are assessed on. For example, mothers with children under age 5 and over age 12 are not asked the full range of BPI items asked of mothers with children between these ages, and our measurement conversion takes these discrepancies into account. Cronbach's alphas measuring the internal consistency of these scales are 0.79 for the internalised and 0.89 for the externalised scores. For BCS70 we took the conduct problems and hyperactivity/ inattention subscales of the SDQ to reflect externalised behaviour, and the emotional problems and peer relations subscales to reflect internalised behaviour. These scales had Cronbach's alphas of 0.81 and 0.73 respectively. Finally, we invert each scale so that all of our child development indicators move in a favourable direction as they increase. This gives a 'non-aggression' score for each country reflecting the absence of externalized behaviour problems, and a 'non-anxiety' score reflecting freedom from anxious or withdrawn behaviour.

We internally standardise all four scores for age by including age and age squared in our regressions. We follow the recommendation of Wiggins and Wale (1996) in this practice rather than use national age norms since our samples are atypical.

As shown in Table 1, the mean for most of the U.S. cognitive scores is around 50 percent although American children scored less well on average on reading comprehension – a measure for which there is no exact parallel in the BCS70. The mean cognitive scores for the British children are higher than those of the American children, especially the mean "early number concepts" maths test for the relatively small group of British four and five year olds. These results do not mean that one group is scoring less well than the other in an absolute sense, but rather that more children in the British sample have scores that fall closer to the highest attainable score. Standard deviations are also smaller for the British children, again suggesting less variation of scores.

In contrast to most of the cognitive scores being in the middle of the range, behaviour scores are on average closer to 100 percent than 50 percent, as most mothers report few, if any, behaviour problems for their children. Fewer internalizing than externalizing behaviours are reported, and British mothers appear more likely to report behaviour problems on average than do their American counterparts.

Table 1 Child outcome variables: descriptive statistics for both countries

	Mean	Std Dev	N
BCS70			
Math Ability Score			
Child aged 4 to 5	0.759	0.098	371
Child aged 6 to 16	0.526	0.155	1,529
Reading Ability Score			
Child aged 4 to 5	0.647	0.081	371
Child aged 6 to 16	0.609	0.174	1,531
External behavioural adjustment	0.762	0.185	1,902
Internal behavioural adjustment	0.844	0.151	1,917
NLSY79			
Math Score	0.482	0.196	1,220
Reading Recognition Score	0.518	0.218	1,223
Reading Comprehension Score	0.464	0.183	1,218
External behavioural adjustment	0.855	0.150	1,299
Internal behavioural adjustment	0.909	0.114	1,327

Maternal Employment

In this paper we focus on mothers' paid work during a child's first year of life as previous research by ourselves and others suggests that the first year is key. Nearly two thirds of the children in both samples had mothers with some paid work during the first year of their lives, but comparison is not straightforward, as we now explain.

Ideally, we would like to distinguish exactly how young each infant had been when their mother returned to, or took up paid work. This is possible to compute from the NLSY79 data, but not in BCS70 where employment histories rely on retrospective reports, mostly at age 30, back to the time their children were born, and questions were not asked specifically about maternity leave. Many employment spells are therefore reported which contain the date of a birth without recording a break. This makes sense when a woman took maternity leave and then returned to her original employer, as her *contract* of employment would not have been interrupted. We have had to conclude that spells of 'employment' which appear to be continuous during the first year of a child's life were almost certainly punctuated by maternity leave, whose exact dates cannot be retrieved. We make the assumption that any British mother who appeared to be employed in the last quarter of her child's first year (months 9-11) was almost certainly actually working in that period, and not on maternity leave, since the statutory entitlement lasted to the 7th month.

Another way in which motherhood and paid work may be rendered more compatible is for mothers to work part-time rather than full-time. In this paper we break our employment measures in months 9-11 following the child's birth into three categories. NLSY79 mothers are classified as working full-time if they report any full-time work during that period (classified as 30 or more hours per week), or part time if the only work they report is less than 30 hours per week. Not working is the third category. As shown in Appendix 2, forty-three percent of children in our American sample had mothers who reported full-time work, 13 percent were employed only part-time, and 44 percent reported no labour force participation during these three months, (although only 36 percent of mothers reported no employment at all during the child's first year). This is similar to the proportion of British children as 35 percent of them had mothers with no employment in the last quarter (and in all likelihood had none during the whole year). Twenty-eight percent of the British sample, had mothers with (exclusively) full-time jobs in the relevant 3 months, and 37 percent had held jobs at least some of which were part-time. As expected, part-time employment appears to be more common among the British mothers (ignoring the different treatment of a few mixed full-time and part-time records in the two datasets).

We cannot tell definitively whether the British mothers who were employed at the end of their child's first year had also been employed outside the home in the early part of the year. However, the prevalence of maternity leave suggests that most were probably not. Among our American mothers, their more detailed work histories show that 83 percent of mothers who were working full-time in the last quarter of a child's first year had been working since the first or second quarter, as were 68 percent of those reporting working part-time only.

Overall, our American sample children have mothers who worked for longer during their infancy, both in terms of hours and (we assume) months. If maternal employment effects on child development are greater when employment is full-time rather than part-time, and when it starts earlier rather than later in the child's life, we would then expect to find a greater impact of maternal employment in the United States than in the United Kingdom.

Additional Control Variables

We include a range of other variables in our analyses to control for moderating, or confounding factors which might affect the interpretation of the outcome variables, or whose omission may bias the measurement of a link between maternal employment and child outcomes (see Appendix 2). In order to detect the full extent of any 'impact', we deliberately do not include (or 'net out') variables which might mediate such a relationship, for example, the level of family income to which the mother's employment may contribute, or the nature of child care arrangements during the time employment separated the mother from the young child.

In both samples the average age of the children is just over 9 years, with a standard deviation of around 3 years. Just under half are girls. We also include an indicator of longstanding health conditions at the time of the child assessments. Such health conditions are more likely to affect the outcome variables at that time than to have been a decisive factor in the mothers' earlier employment behaviour (they are very weakly correlated), although if they had done we could view them also as confounders. These indicators are based on similar but not identical questions in the two surveys hence one cannot be certain whether a higher rate of reported health problems (17 in the BCS70 versus 13 percent in the NLSY79) reflects less healthy children or a more discriminating question wording.

We also include various family demographic measures. The American children have slightly more siblings, as we would expect given that the British mothers are a few years younger. The presence of siblings may impede child development due to competition for parental attention. The presence of older siblings may also have inhibited maternal employment in the index child's first year. Thirty-three percent of the American children were first born compared to 58 percent of the British.

Around two thirds of the children in both samples were living in intact families with both their biological parents at the time of assessment. We assume that both parents were also present during their first year of life, and that the father as well as the mother may have had some input in the child's early development. We do not attempt to infer from partnership history information whether a father-figure was present in the first year of life for all other children. Given national patterns of participation rates within welfare systems, it is less likely that lone mothers of infants in the United Kingdom would have been employed than mothers in two parent families, whereas in the United States the pattern would be the reverse. We additionally control for race/ethnicity in our US analyses. This is not a feature of the British sample, based as it is on women born in Britain in 1970 – a birth cohort containing few members of minority ethnic groups. The percentage of black children who live with a lone mother in our NLSY79 sample is almost double the percentage of white children who do so. This contributes to the higher percentage of children in the NLSY79 overall who live with a lone mother when compared with children in the BCS70.

In many data sets (including these) mother's work is positively associated with child development. This is because other factors, such as a mother's ability or competence are positively associated with both the child outcomes and with maternal employment. It is only when the model is adjusted for these types of spurious relationships that the 'true' relationship between child outcome and maternal employment emerges as the effect on the child of a mother of given ability taking paid work. The NLSY79 includes a measure of aptitude as measured in 1980 by the Armed Forces Qualifying Test, (AFQT). The BCS70 offers various cognitive tests assessed during the mother's own childhood and in these analyses we use reading and maths scores from the age 10 survey.

We also incorporate a measure of the mother's highest educational level attained by the time their children were assessed. We classify American mothers into four groups where nearly half have attended at least some college and one fifth has graduated. Although both samples contain a high proportion of mothers who had their first child at, or before, age 20 (a measure that we include to allow for antecedent and consequent disadvantages that may attach to very early motherhood), the BCS70 sample appears less well educated. Only one third of these British mothers have qualifications to A level or more, and very few have any tertiary qualifications. The lowest educational category of below O level (30 percent in BCS70) is nearly twice as big as the 'below High School' group in NLSY79 (17 percent), and it might be argued that the UK 'O level' group was also not as well qualified as the US 'High School'. So the BCS70 sample are distinctly low attainers, although reassuringly a little better qualified than the equivalent group of 33 year old mothers in corresponding analyses of the NCDS (Verropoulou and Joshi 2009). We also note, however, that the American educational system is more flexible than the British system in allowing people of all ages to return to school and gain an educational qualification equivalent to a High School Diploma, and to then take college classes at a variety of schools and slowly build college credits towards a degree. It is therefore likely that more of our American mothers have achieved formal educational qualifications in recent years than have their British counterparts.

Methods

In our analyses we include variables that reflect characteristics of the child and of the mother. Our data are therefore structured in a two-level hierarchy where children represent the first level and mothers represent the second. Our methods need to take into account the nested structure of the data otherwise standard errors will be underestimated, and the significance of independent variables overestimated. We therefore use multilevel linear modelling which is a variant of multiple linear regression and allows for the residuals of individual observations to be correlated (Goldstein, 1995). Put another way, this method acknowledges that the cognitive and behavioural development of different children within a family is subject to the same influences. The model applied in this case is a random intercept model i.e. where families differ in terms of their intercept only.

If y_{ij} represents the score of the i^{th} child in the j^{th} family, recorded when the child is of school age, then the following equation describes the association of each score with potential explanatory variables:

$$y_{ij} = \beta_0 + \sum E_{ijt}\beta_t + \sum x_{ij} + \sum Z_j\delta + u_{0j} + e_{0ij}$$

β_0 is the average intercept for all families

E_{ijt} is a vector of variables recording the child's exposure to maternal employment at time t in the preschool ages, here in the first year of the child's life, and β_t is a parameter reflecting the impact of maternal employment at age t on outcome y_{ij} .

x_{ij} are other predictors of the Y outcomes pertaining to the i^{th} child in the j^{th} family, directly and independently influencing the outcome, or confounders indirectly influencing both employment as well as the outcome.

Z_j are other contextual predictors of the y_{ij} outcome pertaining to family j , directly and independently influencing the outcome, or confounders indirectly influencing both employment as well as the outcome.

For each outcome y_{ij} the model contains two random effects: u_{0j} and e_{0ij} ; each of these indicates a different source of unexplained variation. The random intercept u_{0j} indicates unexplained differences between families in the average y_{ij} values (controlling for the effects of x_{ij} and Z_j). The random residual e_{0ij} , indicates unexplained variation among the individual children within families.

Linear multilevel models are mixed, containing both fixed and random effects. In this study the models were fitted via maximum restricted likelihood (REML) using STATA 10.0. Fixed effects are analogous to standard regression coefficients and are estimated directly. Random effects are not directly estimated but are summarized according to their estimated variances and covariances. The error distribution of the linear mixed model is assumed to be Gaussian.

Results

Cognitive Scores: Maths

In Table 2 we present our fixed effects results pertaining to two sets of maths scores in the British sample (for those under and over 6 respectively) and the single analysis of maths for all children in the American sample. The first thing to notice is that we find no significant association of either BCS70 maths score or of the PIAT math score with either full-time or part-time maternal employment in the child's first year. Among the other child-related items, age and the presence of limiting health conditions in both samples, and being African American have the expected, generally significant signs. There is no clear tendency for boys to outperform girls at maths, and a tendency for the first born to perform better appears only in the NLSY79. The current family structure terms show a tendency for children living with step fathers to do worse than children living in other types of family structures. Both maternal education and ability are strongly predictive of the child's maths score in the NLSY79. In the BCS70 only the mothers' own maths ability shows any statistically significant association with children's maths scores for the two sets of children, while for the 6-16 year olds there is also a significant relationship with mother having obtained 'O' levels.

Cognitive Scores: Reading

We present estimates for four literacy models in Table 3 as there are two age groups of children in the BCS70 and two different assessments applied to the full age range of children in the NLSY79. We find no association of maternal employment at the end of the first year of the child's life with vocabulary or reading for either of the British age groups, or with reading recognition for American children. There is, however, a well determined negative coefficient of full-time employment on the reading comprehension score: American children whose mothers worked full time in the three months before their first birthday score 1.6 percentage points (or 0.09 of a standard deviation) less on this test than children whose mothers were not employed at this time, and there is more than a 95 percent chance that this estimate exceeds zero.

Other variables included appear similarly related to literacy as they are to maths, although advantages of being first born are evident in both countries. Our measures of maternal education and abilities are also significantly and positively associated with children's literacy, although among BCS70 mothers with children under 6, again, it is only their own maths score at age 10 which predicts their children's naming vocabulary score at any level of statistical significance.

Table 2: BCS70 & NLSY79: Full Model for Maths Scores (Fixed effects)

	BCS70 4-5 years		BCS70 6-16 years		NLSY 4-14years	
	b	z	b	z	B	z
Constant	-0.0577	-0.12	-0.4442	-10.90	-0.7521	-16.60
Mother's Employment (child 9-11 months)						
(ref: No employment)						
Only full-time	0.0237	1.59	0.0077	1.00		
Some part-time	0.0126	0.93	0.0055	0.85		
Mostly full-time					-0.0135	-1.88
Mostly part-time					-0.0012	-0.12
Other Child Level Variables						
Age	0.0124	0.77	0.0119	19.91	0.0163	22.71
Age squared	-0.0033	-0.25	-0.0033	-14.06	-0.0048	-16.01
Girl	0.0143	1.68	-0.0012	-0.24	-0.0088	-1.46
Birth order	-0.0044	-0.62	-0.0044	-1.01	-0.0103	-2.57
Any younger siblings	0.0063	0.22	-0.0031	-0.52	-0.0044	-0.69
Any illness/limiting condition	-0.0239	-2.16	-0.0331	-4.72	-0.0340	-3.67
Race/ethnicity (ref white)						
Black					-0.0249	-2.51
Hispanic					-0.0141	-1.35
Family status at interview (ref: Intact family)						
lone mother	0.0032	0.28	0.0027	0.37	-0.0081	-0.92
step father	-0.0184	-1.43	-0.0193	-2.45	-0.0240	-2.16
other arrangements					0.0815	3.13
Family Level Variables						
Mother's educational qualifications (US)						
(ref: less than high school)						
HS Diploma					0.0380	3.48
Some college					0.0384	3.20
College graduate					0.0560	3.78
Mother's AFQT score (US)					0.1097	6.09
Mother's educational attainment (GB)						
(ref: Low-less than 'O' level)						
Mid – 'O' Levels	0.0015	0.11	0.0159	2.28		
High – 'A' Levels or more	-0.0077	-0.36	0.0105	1.32		
Mother's ability tested at age 10 (GB)						
Maths score	0.2053	4.07	0.0669	2.14		
Reading score	0.0328	0.94	0.0306	1.39		
1 st birth at 20 or before	0.0030	0.15	-0.0053	-0.58	-0.0073	-0.76
N	367		1524		1219	
Log-restricted likelihood	352.03		1259.73		938.84	
(Null model)	369.07		1284.69		872.54	

Table 3: Model for Literacy Scores, BCS70 & NLSY79 (Fixed effects)

	BCS70 4-5 years Naming Vocabulary		BCS70 6-16 years Reading Recognition		NLSY 4-14 years Reading Recognition		NLSY 4-14 years Reading Comprehension	
	b	z	b	z	B	z	b	z
constant	-0.4159	-0.96	-0.4469	-9.75	-0.6398	-11.67	-0.5711	-11.99
Mother's Employment (child 9-11 months) (ref: No employment)								
Only full-time	0.0073	0.56	0.0027	0.30				
Some part-time	0.0128	1.09	-0.0033	-0.44				
Mostly full-time					-0.0002	-0.01	-0.0166	-2.20
Mostly part-time					-0.0051	-0.42	0.0009	0.08
Other Child Level Variables								
Age	0.0271	1.93	0.0127	19.18	0.0136	15.72	0.0131	17.27
Age squared	-0.0180	-1.59	-0.0035	-13.52	-0.0034	-9.55	-0.0037	-11.59
Girl	0.0075	1.01	0.0093	1.61	0.0077	1.05	0.0088	1.38
Birth order	-0.0227	-3.66	-0.0164	-3.27	-0.0080	-1.63	-0.0108	-2.62
Any younger siblings	-0.0261	-1.10	-0.0007	-0.11	0.0023	0.30	-0.0012	-0.17
Any illness/limiting condition	-0.0085	-0.88	-0.0477	-6.04	-0.0458	-4.07	-0.0180	-1.86
Race/ethnicity (ref white)								
Black					-0.0135	-1.10	-0.0276	-2.71
Hispanic					0.0181	1.39	-0.0008	-0.07
Family status at interview (ref: Intact family)								
lone mother	-0.0006	-0.05	-0.0074	-0.86	-0.0117	-1.07	-0.0076	-0.84
step father	-0.0149	-0.80	-0.0212	-2.31	-0.0386	-2.82	-0.0387	-3.36
other arrangements					0.0554	1.74	0.0001	0.00
Mother Level Variables								
Mother's educational qualifications (US) (ref: less than high school)								
HS Diploma					0.0258	1.90	0.0252	2.25
Some college					0.0442	2.96	0.0344	2.80
College graduate					0.0419	2.28	0.0267	1.76
Mother's AFQT score (US)					0.1207	5.39	0.1104	5.96
Mother's educational attainment (GB) (ref: Low-less than 'O' level)								
Mid – 'O' Levels	0.0100	0.98	0.0198	2.42				
High – 'A' Levels or more	0.0052	0.46	0.0301	3.20				
Mother's ability tested at age 10 (GB)								
Math score	0.1157	2.63	0.0795	2.16				
Reading score	0.0306	1.00	0.0641	2.47				
1 st birth at 20 or before	-0.0052	-0.30	-0.0054	-0.51	-0.0065	-0.55	-0.0147	-1.48
N	370		1526		1222		1217	
Log-restricted likelihood	400.98		1077.87		705.90		882.46	
(Null model)	417.36		1067.80		674.42		830.64	

Table 4: BCS70 & NLSY79 Full Model for Behavioural Scores (Fixed effects)

	BCS70 4-16 years Externalised		BCS70 4-16 years Internalised		NLSY 4-14 years Externalised		NLSY 4-14 years Internalised	
	b	z	b	z	b	z	B	z
constant	0.5269	11.19	0.8274	21.35	0.6799	14.38	0.9258	26.86
Mother's Employment (child 9-11 months)								
(ref: No employment)								
Only full-time	0.0038	0.31	0.0100	0.99				
Some part-time	0.0015	0.14	0.0124	1.42				
Mostly full-time					-0.0009	-0.10	0.0154	2.21
Mostly part-time					0.0033	0.25	0.0004	0.04
Other Child Level Variables								
Age	0.0011	1.74	-0.0004	-0.68	0.0031	4.15	-0.0010	-1.95
Age squared	-0.0003	-1.26	0.00001	0.05	-0.0014	-4.29	0.0008	3.24
Girl	0.0677	8.54	-0.0030	-0.47	0.0161	2.03	-0.0086	-1.52
Birth order	-0.0122	-1.82	-0.0007	-0.12	-0.0011	-0.21	-0.0009	-0.24
Any younger siblings	0.0027	0.27	-0.0073	-0.90	-0.0116	-1.38	-0.0088	-1.45
Any illness/limiting condition	-0.0543	-5.10	-0.0660	-7.50	-0.0555	-4.68	-0.0457	-5.29
Race/ethnicity (ref white)								
Black					0.0089	0.69	0.0009	0.09
Hispanic					0.0011	0.08	0.0007	0.06
Family status at interview								
(ref: Intact family)								
lone mother	-0.0614	-5.26	-0.0432	-4.42	-0.0401	-3.50	-0.0386	-4.30
step father	-0.0551	-4.26	-0.0242	-2.25	-0.0291	-1.98	-0.0175	-1.59
other arrangements					-0.1257	-3.52	-0.0841	-3.15
Family Level Variables								
Mother's educational qualifications (US)								
(ref: less than high school)								
HS Diploma					0.0247	1.72	0.0050	0.46
Some college					0.0280	1.78	0.0043	0.35
College graduate					0.0469	2.45	0.0152	1.02
Mother's AFQT score (US)					0.0037	0.16	0.0354	1.94
Mother's educational attainment (GB)								
(ref: Low-less than 'O' level)								
Mid -'O' Levels	0.0242	2.21	0.0144	1.58				
High - 'A' Levels or more	0.0356	2.89	0.0190	1.85				
Mother's ability tested at age 10 (GB)								
Math score	0.0828	1.72	0.1177	2.93				
Reading score	0.0674	1.98	-0.0022	-0.08				
1 st birth at 20 or before	-0.0245	-1.68	0.0084	0.69	-0.0051	-0.40	0.0027	0.28
N	1894		1909		1298		1326	
Log-restricted likelihood	573.49		938.45		619.93		1028.44	
(Null model)	523.22		940.16		638.76		1045.35	

Behavioural Adjustment

We present estimates of the fixed part of our behaviour models in Table 4. With respect to maternal employment, once again we find few estimates significantly different from zero. In this case the one exception is a positive term showing *less* internalized problems among the children of the NLSY79 whose mothers had been employed full-time: their (good) behaviour scores are 1.5 percentage points higher than those of children of non-employed mothers. One interpretation, which requires further investigation, is that these children had more early experience of social settings which has helped their behavioural adjustment – but the same does not apply to externalized behaviour, or either measure of behaviour in the UK.

Although, with this one exception, the behaviour models bear little imprint of maternal employment, we note that they are more sensitive than the cognitive models to family structure and child ill-health. Girls are significantly less likely to display externalized problems. Also in contrast to our models of cognitive development, indicators of maternal ability and attainment tend to be poor predictors of internalized behaviour. Perhaps we have yet to find the right 'confounder' to reveal a supposed underlying negative relationship.

The unexplained part of the model

We now turn to a summary of how much of the random variation in the original data remains unexplained by the models we have fitted. Tables 5a and 5b compare the error structure from the models in Tables 3 and 4 (the 'full' models) with the variability present when only child age (and age squared) is controlled, the 'null' model. Table 5a reports the random element in the BCS70 models and Table 5b presents the same information for the NLSY79. As the data are hierarchical, variances of the unexplained element (random effects) are shown both at mother and child levels, as well as correlations for children within families. For both the NLSY79 and the BCS70 data, variability between families, as evidenced by variances at the mother levels, is significant for all outcomes, apart from Maths scores for BCS70 children ages 4-5 years. In contrast, variability between children is not important in the NLSY79 and is only significant in the BCS70 for the Reading scores of children 6-16, the externalised behaviour scores (null model) and the Maths scores for the 4-5 year olds (full model). Variances at the child level do not decrease between the null and full models, which indicates that the addition of explanatory variables does little to explain variability between children.

Variances at the mother level do decrease with the addition of explanatory variables, however. This overall decrease in the variance at the family level indicates that the full model does well in explaining part of family level variability. For the NLSY79 this decrease is more marked in the cognitive than the behavioural scores. In other words, the addition of variables in the full model does a better job of explaining variability between families in cognitive rather than behavioural scores. For the BCS70 the variance decreases more sharply for the cognitive scores of the 4-5 year olds, then for their behavioural scores, while the least explanation is contributed for cognitive outcomes for older children.

Finally, the correlation coefficients at the child level show that the performance of children within a family is correlated. For the NLSY79 data, correlations are more pronounced for internalised behaviour (0.41) and reading recognition (0.36) while for the BCS70 they are more substantial for vocabulary for young children aged 4-5 (0.40) and reading for older children (0.33).

Table 5a: BCS70 Random Effects: Variance (std. errors in parentheses) at Mother and Child Level for the Null and the Full Models

	Maths 4-5	Maths 6-16	Naming Vocab 4-5	Reading 6-16	Externalised Behaviour	Internalised Behaviour
Mother Level	0.0016	0.0023	0.0035	0.0050	0.0075	0.0058
Null Model	(0.021)	(0.004)	(0.011)	(0.004)	(0.006)	(0.005)
Full Model	0.0007 (0.034)	0.0021 (0.004)	0.0019 (0.021)	0.0042 (0.004)	0.0059 (0.006)	0.0047 (0.005)
Child Level	0.0056	0.0077	0.0020	0.0087	0.0238	0.0146
Null Model	(0.463)	(0.404)	(0.589)	(0.003)	(0.004)	(0.228)
Full Model	0.0059 (0.012)	0.0076 (0.149)	0.0028 (0.701)	0.0084 (0.705)	0.0222 (0.416)	0.0145 (0.222)
Correlation coef.*	0.106	0.216	0.404	0.333	0.210	0.245

* intra-level 2 unit correlation, (i.e. children within families, full model)

Table 5b: NLSY79 Random Effects: Variance (std. errors in parentheses) at Mother and Child Level for the Null and the Full Models

	Maths	Reading Recognition	Reading Comprehension	Externalised Behaviour	Internalised Behaviour
Mother Level	0.0057	0.0087	0.0055	0.0061	0.0051
Null Model	(0.004)	(0.005)	(0.005)	(0.006)	(0.004)
Full Model	0.0031 (0.004)	0.0057 (0.005)	0.0028 (0.005)	0.0052 (0.007)	0.0045 (0.004)
Child Level	0.0077	0.0103	0.0087	0.0142	0.0066
Null Model	(0.877)	(0.582)	(0.919)	(0.676)	(0.528)
Full Model	0.0076 (0.188)	0.0103 (0.811)	0.0087 (0.235)	0.0142 (0.784)	0.0065 (0.592)
Correlation coef.*	0.290	0.356	0.243	0.268	0.409

* intra-level 2 unit correlation, (i.e. children within families, full model)

Discussion

Comparing these British women born in 1970 with their counterparts from the previous national birth cohort, born in 1958, we find a doubling of the first-year maternal employment rate which was only 33 percent among women who were born in 1958 and gave birth between 1973 and 1987 (Verropoulou and Joshi, 2009). This reflects a trend of increasing co-existence of employment and motherhood although it does not demonstrate their compatibility. So we return to our question of whether having an employed mother as an infant has any effect on children's cognitive or behavioural development when they are older. This is a question that continues to elicit considerable debate among academics and in the public arena. The assumption that maternal employment has negative impacts on children appears to underlie the recently reaffirmed fears that family life suffers if mothers go out to work (Scott, 2008). To address this question we assembled longitudinal data from two second generation cohort studies from two separate countries, each with its own regime of maternal labour force patterns, but with fairly comparable samples, child outcomes and predictor variables. To see if cognitive and/or behavioural outcomes of school age children are associated with mothers' employment when their children were babies, we utilised multi-level modelling. Further, because our data are longitudinal and have followed mothers over many years, we are able to include more extensive measures of a mother's abilities, measured at an earlier stage in her life course, than are available in cross-sectional data. Despite the added strengths of our approach, however, the bottom line is that our results still reveal very little association between the paid work by mothers of infants and either cognitive or behavioural outcomes in childhood and adolescence.

For women entitled to maternity leave from an existing job, the timing of post-birth employment is likely to reflect the provisions of maternity leave which vary from woman to woman, employer to employer and, of course, from country to country. As we noted earlier, widespread and guaranteed maternity leave is a much more recent phenomenon in the United States. Given that the children of our sample NLSY79 mothers were born between 1984 and 1996, i.e. many of them were born before the implementation of the 1993 FMLA, there would have been less opportunity for NLSY79 mothers to have been granted a job-protected break of any extended length of time as a result of childbirth. From the NLSY79 data we know that of the 64 percent of mothers in our sample who reported any employment in the first 12 months following the birth of their child, 86 percent reported at least some paid work during the first 6 months, and 77 percent were also employed during the last quarter of their child's first year.

Considering the very modest and mixed results of prior studies in this area, we hypothesised that we would be more likely to find effects of full-time rather than part-time employment, and given the more extensive nature of maternal employment during infancy in the United States than in the United Kingdom, we also hypothesised that any maternal labour force effects would be stronger in our sample of American children. Our results provide support for both of these hypotheses. First, they show very little, if any, discernible impact of part-time maternal employment in this early stage of childhood on either type of outcome later in childhood and early adolescence. They also reveal no association between full-time employment and child development in Britain, although in the United States there is some negative association between full-time maternal employment during infancy on the one hand and reading recognition and, perhaps, maths among children aged 4-14. The estimated 'effect' of employment on this reading score is, however, relatively small – a margin of 1.7 percentage points between having a mother working full-time or not at all, which is less than half the apparent disadvantage associated with having a stepfather.

We had expected more adverse outcomes of mothers working fulltime in the US than the UK due to American mothers returning to work earlier during the infancy period. The evidence within the US sample is not conclusive however. In additional analyses (results not shown here) we looked more closely at the length of time that our American sample mothers who reported working full time during months 9-12 had actually worked during their child's first year of life, and at all returners in each of the four quarters. We did not find, however, that earlier returners had worse child outcomes than later returners, although the coefficients for each group were within each others confidence limits. Our only caveat concerns children whose mothers worked full time during the second or third quarter of their infant's life who tended to fare more poorly in terms of reading comprehension than did children whose mothers reported no work during these months

We were also interested to see if cognitive and behavioural dimensions of development followed the same patterns. Although our few statistically significant estimates of employment 'effects' on cognitive

outcomes were negative, we did find a statistically significant protective association in our American sample of maternal employment and internalizing behaviour problems in the children. Before concluding that maternal employment has beneficial as well as harmful consequences, however, it is worth noting the large amount of variability left unexplained. It may be that day care arrangements are an omitted confounder: if we could distinguish between children who had been in 'good' versus 'inadequate' day care we might be able to turn the positive coefficient into a negative one, but this rather begs the question of how anyone decides what is 'good' daycare (or indeed a good mother!)

Our results also may not be relevant to the experiences of women in birth cohorts other than those we capture in our two data sets, to children born to older women who are not represented in our analyses, to outcomes that we do not analyse here, or to those that we do but when our subjects are older. How maternal employment might impact children born to later cohorts of women remains to be seen, and is likely to depend on the circumstances under which the care of young children and employment can be balanced. However we do note that in the United Kingdom, any negative outcomes associated with early maternal employment are even less discernible among children of the BCS70 than they were among children assessed earlier in both the NCDS and the ALSPAC studies (Verropoulou and Joshi 2009, Gregg et al 2005).

Although maternal employment forms the focus of our paper, some other results bear highlighting. Estimates of the intergenerational transmission of educational advantage are on the whole far more robust than any relationship between maternal employment and child development. However these vary by outcome, age of child, and national context. In the United States, cognitive benefits accrue for children whose mothers have more than a high school education. Higher maternal ability, as measured by the AFQT score, is also beneficial for children's own academic achievement, and is additionally associated with lower anxiety. Results from the United Kingdom are of a similar pattern but are more mixed in strength. British mothers' maths scores are particularly predictive of their offspring's maths scores, especially for children under 6 years. In both countries we find that maternal education levels are less closely associated with children's internalizing behaviour problems, than they are with the kinds of behaviours classified as externalizing or with our cognitive measures.

In this paper we do not delve into the kinds of factors that might mediate, or interact with such relationships as described above. For example, what are the potential pathways through which a mother's education might impact her child's cognitive attainment? How might the involvement of the child's father or grandparents offset a mother's presence elsewhere? How might the type of childcare arrangements chosen by, or available to, working mothers, or the flexibility of employment hours mediate the relationship between maternal employment and children's development? It may be that adaptive behaviour is already addressing the concerns expressed in public attitudes. We also leave the question of how independent are the various dimensions of child development investigated here to future research, when we plan to estimate multivariate hierarchical linear models that allow scores to be nested within children as well as children within families.

Conclusion

Despite recent public concern regarding maternal employment of mothers with young children, especially in the United Kingdom, the bulk of the evidence therefore supports the view that it really doesn't matter much one way or another if mothers are in the labour force when their children are very young, especially if maternal employment is part time.

Of course, 'no evidence of harm' is not quite the same as 'evidence of no harm'. We are unable to prove that children whose mothers did not go out to work would not have suffered if they had – the unobserved counterfactual in an observational study. However, our use of longitudinal data helps us rule out reverse causation, and to search for indicators of possible confounders we have included a wide range of additional child and maternal variables in our analyses to help overcome this problem of spuriousness.

As Barack Obama noted in his 2006 book, social conservatives are still disapproving of mothers working outside the home, but most families have two earners out of necessity. The current economic climate on both sides of the Atlantic does not make it easy for mothers to stay at home with their young children, but the stress associated with an economic necessity for mothers to be in the labour market should not be compounded by unsubstantiated concerns regarding negative effects of maternal

employment on later child development and emotional well-being. Obama argues: 'If we are serious about family values, then we could put policies in place which make juggling work and parenting a little easier.' (Obama, 2006, p.342). Policies such as flexible work schedules, parental leave and flexible hours, are, he noted, already further advanced in UK than in the US and these findings support consolidating such measures in both countries. Nothing we have found here suggests an important or inevitable adverse pathway for the two sets of children we studied. Further evidence may yet reveal some negative impact on other or later outcomes, but so far, there is little evidence of harm to these school-age children from maternal employment during a child's infancy, especially if the employment is part-time, and in a context where several months of maternity leave is the norm, as it was already in the UK in the 1990s.

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Appendix 1: Selection into Sub-samples

BCS70 Women in 2004-5:	All women interviewed in 2004-5 (CMs)		All Biological Mothers		All Biological mothers with a first birth before 2000		Study Sample 50% of previous column less cases with missing items, plus a few adoptive mothers	
Educational Attainment	Mean	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	
Low – less than ‘O’ Level	0.232	0.267		0.302		0.295		
Mid – ‘O’ Levels	0.325	0.354		0.374		0.378		
High – ‘A’ Levels or more	0.442	0.379		0.324		0.326		
Age at first birth		26.25	4.53	24.66	3.67	24.32	3.48	
Sample size	5021	3425		2747		1235		

NLSY79 Women aged 35-38 in 2000:	All women interviewed in 2000 (CMs)		All Biological Mothers		All Biological Mothers interviewed in 2000 with at least one child 4-15 in household		Study Sample (as previous column less non-respondents on child assessments or other items)	
Educational Attainment	Mean	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	
Less than High School	0.094	0.104		.086		0.166		
High School graduate	0.420	0.446		.448		0.360		
Some College	0.274	0.270		.273		0.267		
College Graduate	0.212	0.179		.192		0.207		
Age at first birth		23.06	5.27	23.28	4.46	23.38	4.32	
Sample size	1796	1466		1055		840		

Appendix 2: Descriptive Statistics for explanatory variables in regressions, at two levels in two countries

Child Level Predictors	N	BCS70 2083		NLYS79 1413	
		Mean	Std Dev	Mean	Std Dev
Early maternal employment					
Mother's Employment History					
Child aged 9-11 months					
Only full-time employment		0.279			
Some part-time employment		0.366			
Mostly full-time employment				0.431	
Mostly part-time employment				0.134	
No employment		0.355		0.435	
Other Child level Predictors					
Child's age, months		111.24	39.188	114.18	35.420
Child's age, months squared (div by 100)		139.03	95.628	142.90	80.284
Child's sex: female		0.495		0.486	
Child's Birth Order		1.568	0.782	2.139	1.130
Any younger sibling		0.415		0.542	
Any longstanding illness		0.171		0.132	
Child's race					
Hispanic				0.170	
Black				0.270	
Other				0.560	
Family status at interview					
Intact: child lives with both natural parents		0.668		0.622	
Step: child lives with step-father		0.145		0.106	
Lone: mother currently alone		0.187		0.256	
Other arrangement, mother is present				0.016	
Family Level Predictors					
Family Level Predictors	N	BCS70 1235		NLYS79 840	
		Mean	Std Dev	Mean	Std Dev
Mother's educational attainment					
Low – Less than 'O' Level		0.295			
Mid – 'O' Level		0.378			
High – 'A' Levels or more		0.326			
Below High School				0.166	
High School				0.360	
Some College				0.267	
College Graduate				0.207	
First child born at 20 or earlier		0.215		0.312	
Mother's reading score at age 10 years		0.590	0.206		
Reading score missing		0.259			
Mother's math score at age 10 years		0.599	0.149		
Math score missing		0.259			
Mother's AFQT score				0.436	0.286

EUCCONET

Reflecting growing interest in cross-national longitudinal research, the first meeting of EUCCONET took place in Paris on 17th February 2009. This new European Science Foundation-funded network (chaired by Henri Leridon, Director Emeritus of Research, Institut National d'Etudes Démographiques, Paris, Director of the planned French birth cohort study, ELFE with deputy, Heather Joshi, Director, Centre for Longitudinal Studies, London), brought together representatives from new and existing birth cohort studies, across a range of European countries. In a most successful meeting, it was agreed to establish a website for sharing communications about the development of these studies, and to set up a number of working groups to share knowledge and experience on key issues in the development of these studies, including:

- Specific instruments for measuring child development
- Designing specific materials for children interviews
- Different modes of data collection
- The role of fathers in child cohorts
- The maintenance of large cohorts
- Record linkage
- Data management

The establishment of other thematic groups will follow. The idea is to support a degree of harmonisation across new studies which will enable effective cross national cohort study analysis to be undertaken.

Such ventures into cross-national longitudinal research are already well established in relation to household and other panel studies, such as the Cross National Equivalent file based in Cornell University, and in Europe such collaborations as ECHP (household panels) and SHARE (ageing studies). A comparable cross-national initiative in relation to birth cohort studies will be a major milestone in the development of international longitudinal research resources.

New UK birth cohort study

Following a scoping study done by Longview, the think tank that hosts LLCS, on the 'Scientific Case for a New Birth Cohort Study', the British Economic and Social Research Council has now announced success in raising over £30million to support a UK birth cohort study facility for the development and use of the UK birth cohort studies. This includes support for a new birth cohort study, accounting for over 4/5ths of this grant, to begin in 2012. An invitation to tender for the Principle Investigator role and team was announced on April 8th 2009; the team will be appointed in summer 2009, and start work by the autumn. The Longview report can be viewed, together with a follow-up report on costed design options for the new study at, www.longviewuk.com/pages/reportsnew.shtml. The invitation to tender can be requested from birthcohortproject@esrc.ac.uk – closing date, 30th June, 2009.

Scottish School Leavers Survey suspended

The Scottish Government announced on 31 Oct 2008, that following careful consideration of the purpose and use of the Scottish School Leavers Survey, the current suspension of the survey would be extended indefinitely. This announcement coincided with the publication of an options report.

The ALSPAC Forum for Social and Economic Researchers

This Forum is a resource aimed at researchers in social sciences and related disciplines who are using or may be interested in using data from the Avon Longitudinal Study of Parents and Children (ALSPAC), based in Bristol, England. New members welcome!

NEWS & EVENTS

In memory of Neville Butler

In company with James Douglas and Mia Kellmer Pringle, Neville Butler, who died in February 2007, was one of the pioneers of large scale longitudinal research in Britain. He was instrumental in establishing both the 1958 and the 1970 birth cohort studies, and made a major contribution to supporting the Millennium Cohort Study. To celebrate Neville Butler's life, two annual events have been established:

Neville Butler Memorial Prize – funded by the Economic and Social Research Council, this prize will be awarded annually to an early career researcher for a paper reporting a significant contribution to longitudinal study conducted in the UK, with a view to publication in LLCS. The first award of the prize took place in a ceremony in a UK Parliamentary building on March 5th 2009.

Neville Butler Memorial Lecture – on 3rd April 2009, at Imperial College London, Professor Neal Halfon, who leads the work in the new US National Children's Study site in Los Angeles, gave the first lecture of this new annual series. He spoke about the links between the US Study – based on 100,000 pregnancies – and the British birth cohort study series, and ranged widely over the life course approach to medicine and the great value of longitudinal studies in realising its full potential.

For more details of both these items click [here](#).

Events

'Economics of Diet and Obesity' – 1 Day Event, free of charge, Wednesday 20th May 2009. Goldney Hall, University of Bristol, England.

<http://www.bristol.ac.uk/ifssoca/outputs/conferences/ruhm0509.html>

ESRA 2009 – The European Science Research Association will be holding a Survey Methodology conference in Warsaw, Poland 29th June – 3rd July 2009, in part of the University of Warsaw Library.

<http://www.surveymethodology.eu/conferences/warsaw-2009/>

The **EUROEPI2009 Congress, 'Epidemiology for Clinical Medicine and Public Health'** will be held in Warsaw, Poland, 26th – 29th August 2009, at the Old Library of the University of Warsaw.

<http://www.euroepi2009.org/>

Exploiting Existing Data for Health Research, International Conference, 17th – 19th September 2009, Training Workshop, 12th – 16th September 2009, University of St Andrews, Scotland.

<http://www.sdhi.ac.uk/Plannedconferences.htm>

The **17th annual workshop of the European Research Network on Transitions in Youth** will take place at Burgundy University, Dijon, France, on 17th – 19th September 2009.

<http://www.u-bourgogne.fr/iredu>

The **XXVI IUSSP International Population Conference** will be held at the Palais de Congress, Marrakech, Morocco, 29th Sept – 2nd Oct 2009. This will be the first IUSSP International Population Conference to be held on the African continent and in an Arab country.

<http://www.iussp.org/marrakech2009/index.php>

'Longitudinal Surveys: from Design to Analysis', Statistics Canada's International Methodology Symposium 2009, marks the 25th anniversary of these events. It will take place at the Palais des Congrès conference centre in Gatineau, Ottawa, Canada, 27th – 30th October 2009.

<http://www.statcan.gc.ca/conferences/symposium2009/index-eng.htm>

Longview annual conference, Cambridge, September 21st – 23rd, 2009.

The theme of the meeting will be the case for establishing a Society for Longitudinal and Life Course Research and setting in motion the process for doing so. See Longview website for details and updates www.longviewuk.com

New!



The Craft of Life Course Research

edited by Glen H. Elder, Jr., and Janet Z. Giele



This book brings together prominent investigators to provide a comprehensive guide to doing life course research, including an "inside view" of how they designed and carried out influential longitudinal studies. Using vivid examples, the contributors trace the connections between early and later experience and reveal how researchers and graduate students can discover these links in their own research. Well-organized chapters describe the best and newest ways to:

- Use surveys, life records, ethnography, and data archives to collect different types of data over years or even decades.
- Apply innovative statistical methods to measure dynamic processes that result in improvement, decline, or reversibility in economic fortunes, stress, health, and criminality.
- Explore the micro- and macro-level explanatory factors that shape individual trajectories, including genetic and environmental interactions, personal life history, interpersonal ties, and sociocultural institutions.

The Craft of Life Course Research

Edited by **Glen H. Elder, Jr.**, Howard W. Odum Distinguished Professor of Sociology and Research Professor of Psychology, University of North Carolina, Chapel Hill & **Janet Z. Giele**, Heller School for Social Policy and Management, Brandeis University

"This book illuminates the utility of diverse methodologies, from behavioral genetic analysis to cross-national and historical comparison. It is unique in its scope, including qualitative (life story, ethnography, diary) and quantitative (hierarchical growth, latent class, and group-based trajectory models) approaches. Students will learn how to formulate research questions, locate data sources, and increase the potential of existing data through recasting and supplementation. Ideal for methods courses and substantive courses on aging in social context." - Jeylan T. Mortimer, Life Course Center, Department of Sociology, University of Minnesota

"This is a most important book in which the quality of the contributors and editors shines through the pages; a major contribution to the life course literature." - John M. Bynner, Emeritus Professor and former Director, Centre for Longitudinal Studies, Institute of Education, University of London, United Kingdom

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