

# Time for bed? Sleep, health and development in the first decade of life: findings from the Millennium Cohort Study

Yvonne Kelly

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**Abstract** Our need for sleep has intrigued scientists for centuries, and recent research in children and adolescents demonstrates more clearly than ever before the links between sleep and healthy development. This presentation highlights our findings from the analysis of data on over 10,000 children from the UK Millennium Cohort Study (MCS). Revealed are links between bedtime schedules and various aspects of healthy development. We show that the regularity of bedtimes is important for markers of intellectual ability and behavioural problems. This may be to do with disruptions to natural body rhythms leading to sleep deprivation, which undermines the brain's ability to acquire and retain information and to regulate behaviour. We find that later bedtimes are linked to the risk of childhood obesity which may be due to hormonal influences. Given that early child development has profound influences on health and wellbeing across our lives, it follows that disruptions to sleep, especially at key times in development, could have long-term implications too.

**Author/Speaker** Yvonne Kelly, Professor of Lifecourse Epidemiology at UCL and Associate Director of ICLS. Her research interests include the causes and consequences of socioeconomic inequalities in child and adolescent health and development.

**Note** ICLS hosted a policy seminar on Sleep & Health at UCL on 3 June 2014. The seminar was chaired by Richard Bartholomew, (former), Chief Research Officer, Children, Young People and Families Directorate, Department for Education and the presentations co-ordinated by Professor Amanda Sacker, Director ICLS. Transcripts from this event, including this paper, have been made available via the ICLS Occasional Paper Series. This series allows all (those who were or were not able to attend) to read an account of the presentation. Other papers in the series include:

OP13.1 Scheduled versus demand feeding of infants: how do different feeding modes affect sleeping patterns in older childhood, and do they affect the risk of obesity? Maria Iacovou, University of Cambridge

OP13.3 Troubled Sleep: A cross-national study of the influence of age, health, social and psychosocial factors. Gopalakrishnan Netuveli, UEL

OP13.4 Sleep disturbance, sleep duration and mortality in British civil servants. Jessica Abell, UCL



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# Time for bed? Sleep, health and development in the first decade of life: findings from the Millennium Cohort Study

Yvonne Kelly, June 2014

## SLIDE 1

*What are the motivations for doing this research: Well, there's been an explosion in the amount of research published over the last couple of years looking at the links between sleep and health and sleep and functioning, particularly in older age groups. In terms of the earlier parts of the life course most of the work done focused on youngsters of exam age. So looking at teenagers and their sleep patterns in relation to their GCSE results and A-level results and so on. Huge amounts of this work come from the US and other parts of the world. There's also quite a lot of work done looking at babies. But there was this gap with only, until a couple of years ago, a handful of studies which looked at the amount of sleep children were getting and the regularity of sleep schedules in relation to aspects of their development. So that's the academic context or motivation for this particular work I'm going to show you.*

*And we set that against the busy schedules of family life. Many of us who are parents have increasing – it seems like increasing – demands on our time in terms of work schedules, sometimes working long unsociable hours, shift work and so on. Children also appear to be increasingly scheduled in terms of their daily activities. Especially when they enter school. There are breakfast clubs or after school clubs and extracurricular clubs, of all different varieties, take place outside of the school setting too. So children have enormous amounts of their time packed with scheduled activities.*

*We are interested in this from a social context,*

A rectangular box with a white background and a thin black border. At the top right, there is a teal header with the UCL logo. The main text is in blue and black, matching the slide title. At the bottom, there is a small teal box with white text containing the presenter's name, affiliation, and website.

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ESRC International Centre for Lifecourse Research in  
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*parents, families having busy schedules, children having busy schedules, and what happens in those scenarios, does family time get squeezed? So if for example we're getting back from the office at eight/nine o'clock at night and you have young children is it a good idea that their bedtime perhaps might get pushed back so they get to see their parents when they get home from work, for example. Or if work schedules and children's own extracurricular schedules change from day to day is that okay, if children go to bed at different times on different nights depending on whether they're going to Cubs or Brownies or going for a swimming lesson and so on. So we're interested in the broader family context for a set of studies that we've done where we've looked at markers of sleep and children's development.*

## SLIDE 2

*This slide just shows our research questions. So our first question was to see whether sleep schedules were related to aspects of development. Secondly we wanted to look across early childhood – and I'll say a bit more about the data – but essentially we were looking from age 3 through to age 7. We've also analysed these data where we have information on these children at age 11 but I'm not going to present that today because we haven't published that yet. And we wanted to see if these relationships between markers of sleep and children's development built up over childhood or increasing the dose. So if you increase the dose of a particular sleep schedule over early childhood did you have a corresponding change in their markers of their development? And lastly we wanted to see if there was a change in that*

### Research questions

- 1) Are bedtime schedules linked to markers of early child development – learning and behavioural?
- 2) Do effects of bedtime schedules build up over early childhood?
- 3) Are effects reversible?

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*regularity of that sleep schedule at some point during this early childhood period whether that would result in some change in the marker of development that we were interested in. I'll go back over these questions as the presentation goes on.*

## SLIDE 3

*These Millennium Cohort Study data we're looking at is a longitudinal sample. We're looking at over 10,000 children for whom we have information from age nine months, 3, 5, and 7 years. The markers of development that we're particularly interested in are markers of their cognitive functioning, so their reading scores, scores of tests of maths and spatial abilities when they're aged 7. We're interested in looking at their social and emotional development. These are things like hyperactivity, problems with conduct, problems with emotional issues, siblings, and problems with peers. And I am going to show you the results for which we used a summed behavioural difficulties score. So it's not looking at those individual things separately, it's looking at the sum measure of behavioural difficulties.*

*And in terms of sleep when children were aged 3, 5 and 7 their parents were asked, 'Does your child have a regular bed time on schooldays or weekdays?' They could answer yes always, yes usually, sometimes, or never. And we grouped*

### Information used

- Cognitive – reading, maths, spatial
- Behavioural difficulties
- Bedtimes – time and regularity

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*the 'always' and the 'usually' together as children who had regular bedtimes. We grouped the 'sometimes having a regular bedtime' with the 'not having a regular bedtime' because we felt that qualitatively different to say well sometimes my child has a regular bedtime means that they don't really have a regular bedtime. And when the children were aged 5 and 7 the parents were asked what time that was, what the time was their regular bedtime.*

## SLIDE 4

*The next slide shows, some of the vast array of things that co-vary with the time that children go to bed and the likelihood of them having a regular bedtime and also influenced markers of their development, their cognitive development and their social development. This whole range of socio-economic markers, markers of psychosocial environment and home, so what's going on between the parents and the child, the interactions between parents and children, how the parent feels about the child, the sorts of things the child does, their home learning activities, whether the child is read to, how much TV they watched, their markers of both physical activity. A whole range of things we*

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### Other information taken into account

Gender, child's age, mother's age, parity, family income, parent qualifications, maternal depression, discipline strategies, ever breastfed, ever skipping breakfast, home learning, TV and computer use, parental employment, parents feel they have enough time with child, child attends breakfast club, any childcare, reading stories, TV time rules, overcrowding, bedwetting, sleep disturbed due to wheezing, TV in bedroom.

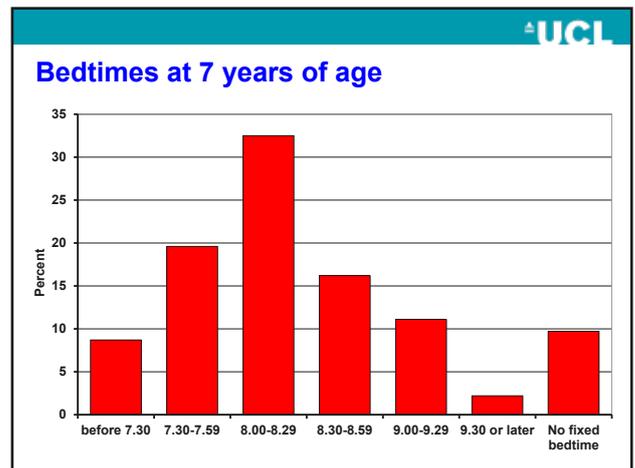
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*took into account when we were trying to isolate the association between markers of sleep and children's development, net of all of these co-varying factors.*

## SLIDE 5

*This next slide just shows you the distribution of these bedtimes at age 7. And it shows from left to right bedtimes in half hour slots. You can see that the most common category for 7-year olds would be going to bed between 8 and 8.30. At this age it takes children about half an hour to fall asleep once they've gone to bed. Or so the books tell me, it never happened with any of my children. They always seemed to be up and down and going to the loo and getting another drink of water. But certainly on average it takes children about 30 minutes to fall asleep. So children who'd be going to bed at 8.30 would be falling asleep about 9 o'clock. And then typically they will be getting up between 7 and 7.30 in the morning. Which would give them roughly ten, ten and a half hours sleep. And for this particular point in the life course on average a 7-year old needs between ten and eleven hours of sleep per night.*

*On the right hand side you can see that later bedtimes, 9 o'clock and later than 9.30, later than 9.30 is relatively rare, a couple of per cent, and we actually combined those children in with those who went to bed between 9 and 9.30 to give an after 9 o'clock at night group. This would*



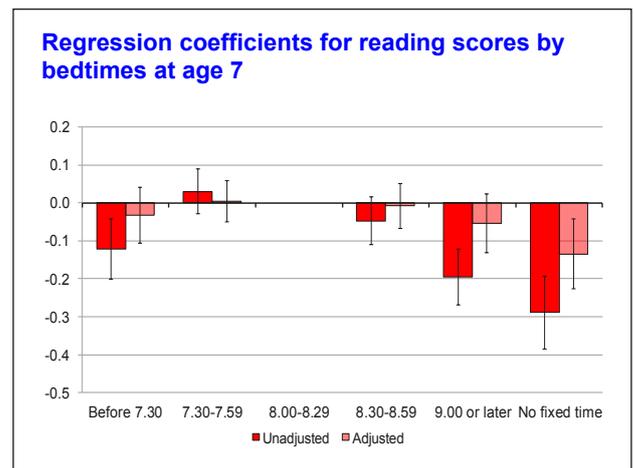
*mean that they would be having less than, on average less than ten hours sleep. Which doesn't represent very short sleep duration. We didn't have enough children in the sample actually to detect very short sleep durations. And the right hand bar at the end shows that about 10% of children did not have regular bedtimes on a school day or a weekday.*

## SLIDE 6

So the first research question was – Is bedtime and are these markers of bedtimes related to children’s development? This slide shows the relationship between time of going to bed, if a child has a regular bedtime, and their reading scores. And as you can see lower scores are worse, okay, so we’re going below the X-axis. The children with a very early bedtime had lower scores than children with our reference group as the 8 to 8.30 group and children with later bedtimes in the darker red bars there also having lower scores on tests of reading at age seven.

When we adjust for a range of co-varying factors those differences largely disappear but still the children with earlier bedtimes have lower scores but the lower scores for the children with later bedtimes are largely explained by the distribution of other factors. And the major contributors to the attenuation, to getting rid of that difference for the children with later bedtimes, was their socioeconomic status.

However for children with the non-regular bedtimes there on the far right hand end the difference was small but it was statistically different. So children with non-regular bedtimes still had lower scores on tests of reading at age 7 when we looked cross-sectionally. And we see the exact same picture when we look at maths scores and when we look at scores of spatial ability. And the same when we look at age 5 as well. So we were seeing these consistent cross-

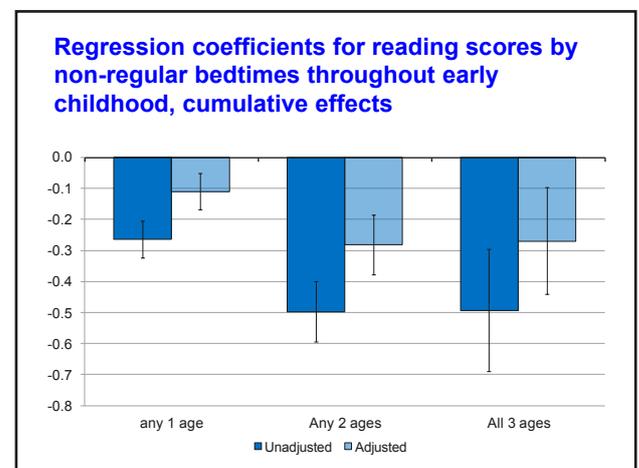


sectional relationships between markers of sleep and children’s scores in terms of their cognitive function tests.

So really we looked at this and we thought well, that’s interesting. This stubborn relationship between not having a regular bedtime and lower scores is going right across the range of these cognitive function tests. And from a biological point of view that makes sense because if you’re going to bed, if you’re chopping and changing bedtimes from night to night it induces a state which is related to something like jetlag. And which then impacts in all sorts of ways on the developing brain. So it makes it less easy for the child to consolidate memories and to learn tasks on a day to day basis. So it’s a biological basis of why not having a regular bedtime would impact on children’s cognitive function.

## SLIDE 7

The next research question was does this build up over childhood? Does increasing the dose of not having a regular bedtime relate to markers of children’s development as we move across childhood? This next slide suggests that it does in that on the left hand side not having a regular bedtime at any one point during this early childhood period, so at age 3, 5, or 7. The next bar shows not having a regular bedtime at any two points. And then on the far right not having a regular bedtime at all



## SLIDE 7 continued

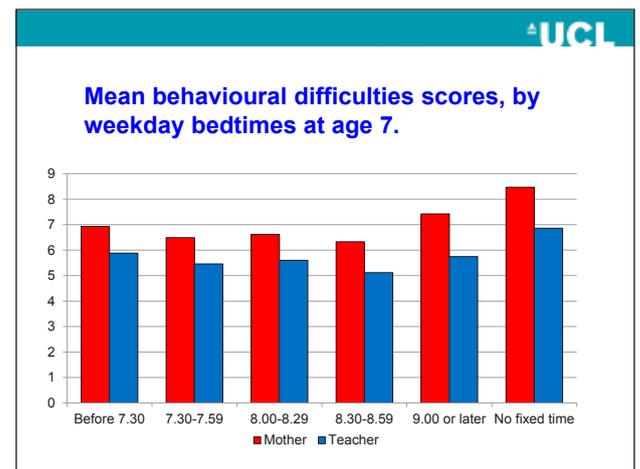
three time points, so 3, 5, and 7, compared to children who did have regular bedtimes. You can see a stronger relationship as children have non-regular bedtimes more often in the early childhood period in the darker bars. And even then when we control for all those co-varying factors we see an attenuation in the

relationship, so a reduction in the relationship, but it still remains quite strong, 0.2, 0.3 of a standard deviation is a medium sized relationship. So it's not trivial. It's not massive but it's a medium sized relationship or moderate relationship even when we take account of all of these different environmental factors.

## SLIDE 8

Let's look at children's behavioural difficulties: This slide show at age 7 there was data on mothers and teachers assessments of children's behavioural difficulties. And I'm just showing you this very descriptive slide because it shows that both for mothers and for teachers the overall scores for teachers in the blue bars are a bit lower than those for mothers but this shows the same rough pattern across the bedtimes. You get the lowest scores, – lower scores are better when we're thinking about behavioural difficulties – around the eight to nine mark with earlier bedtimes and later bedtimes and non-regular bedtimes associated with higher scores – with worse scores – on assessments of behavioural difficulties.

Just like we saw with tests of reading, maths and spatial abilities once we control

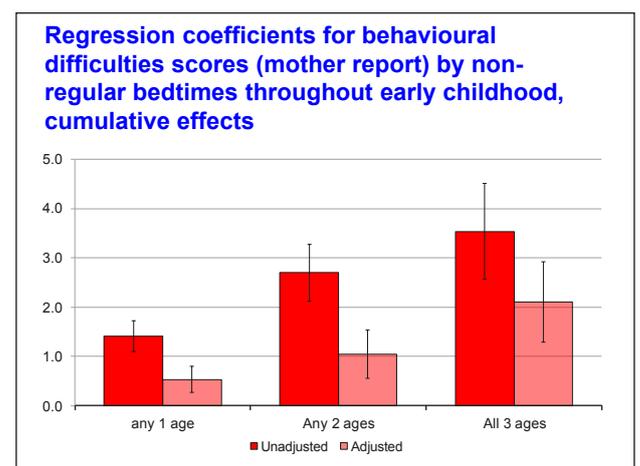


for a range of co-varying factors, particularly socioeconomic circumstances, we see that these differences for the early bedtimes and for the late bedtimes largely disappear. But we see that the differences for non-regular bedtimes remain stubborn and relatively large.

## SLIDE 9

The second question is do the response relationships build up, do they accumulate through childhood? And this graph suggests that they do. This slide is from mother reports. We see the same when we look at teacher ratings of children's behaviour. So rather like the previous graph with one exposure or with one lot of non-regular bedtimes, two lots, three lots throughout early childhood you see this stepwise increase in behavioural difficulty scores. And in the darker red bars are unadjusted – the raw relationships – and in the paler bars when we adjust for all of those co-varying factors.

Here for always having a non-regular bedtime



on the far right hand side a difference of 2 points to give you an idea of the metric would be equivalent to something like 0.4 of a standard

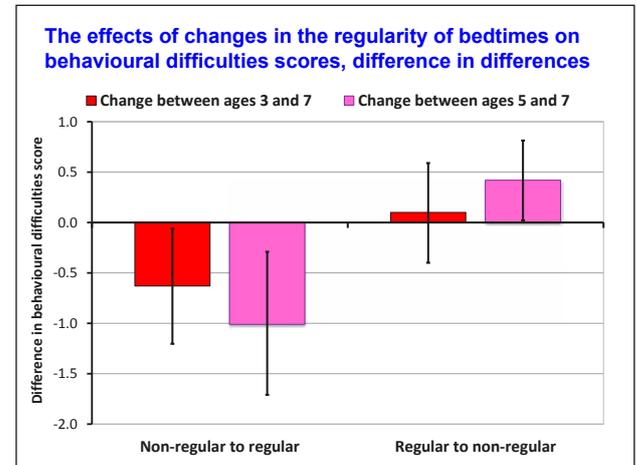
## SLIDE 9 continued

deviation. So again the size of the relationship is by no means trivial. And a difference of 2 points at this age has been shown in other

studies to be predictive of later psychological distress in adult populations.

## SLIDE 10

Now in epidemiological research and social research we're trying to get beyond correlation analysis which is essentially what I've shown so far. And we try, if we have the opportunity to look at change, when circumstances change, that gives us a slightly different handle on the nature of the relationship or it gives us a robustness check if you like for the nature of the relationship. So we had information about children's bedtimes but we also had information on children's behaviours right throughout this early childhood period. So by factoring in the earlier behaviours we looked at what happened if they changed their bedtimes, whether there was an improvement or if there were deleterious impacts on the behavioural scores. And this slide shows the results of that difference analysis. On the left hand side is fixing so it's going, if we think that non-regular bedtimes are related to worse outcomes, if we fix that or if that situation is somehow resolved, so from children who go from not having to having regular bedtimes we see a reduction, the values are below the horizontal line in the behavioural difficulty scores by age 7. And here the change happening



between ages 5 and 7 years on the second of those two bars are 1 point difference. It's small but not trivial in terms of these behavioural difficulties scores. On the right hand side of the graph much weaker evidence but some suggestion that from children who change from having to not having regular bedtimes, particularly between ages 5 and 7 there on the right hand side, there is some deterioration or some worsening in terms of their behavioural difficulties score. So some suggestion there about this idea of reversibility, if you were to change the bedtimes does it impact either way on children's behavioural difficulties.

## SLIDE 11

So I will conclude by summing up that there do appear to be some important links between markers of bedtimes, particularly this marker of regularity around bedtimes, which makes sense from a biological point of view if we're thinking about effects akin to jetlag. These relationships or these associations do appear to accumulate; they build up over the early childhood period. And there is some evidence, some partial evidence for reversibility, so for children whose bedtime schedules change, there appear to

### Conclusions

- Having regular bedtimes during early childhood is an important influence on children's development
- Effects appear to accumulate through childhood
- Some evidence of reversibility

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## SLIDE 11 continued

*be changes at least for their behavioural difficulties. We haven't done this in detail yet for their cognitive scores but there may be reasons why you might not see markers of cognitive*

*performance responding as much as markers of children's behavioural difficulties scores appear to do when we see changes in bedtimes.*

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## SLIDE 12

*From a policy point of view there are clearly a whole range of possibilities for this, especially if this work is replicated in other studies and with later sweeps of data on young children. There are clearly quite a lot of policy messages that we could get from this work. Health and other professionals for instance who come in routine contact with children could implement fairly straightforward, simple checks of regularity of bedtimes and whether children do have fairly regular bedtime schedules. We're not talking about going to bed at the same time every night come hell or high water. We're just talking about generally having a regular schedule when it comes to bedtimes.*

*And indeed we believe that Kids Company, the charity who work with disadvantaged children across the country, are implementing in their initial checks with their clients who they come into contact with, they are starting to ask those young children and their parents about the sleep schedules.*

*In terms of children's own education there are a raft of opportunities through various kind of education programmes that take place within the school setting around healthy diets and healthy exercise and this, that and the other. Sleep and sleep scheduling could become very much part of that. And young children could receive information about that. I mean, my children come home from school and they're constantly giving me all sorts of advice about diet and alcohol and cigarettes and all sorts of things. So sleep could be generally built in as general lifestyle information to children right throughout their schooling.*

*And I put public awareness campaigns on the*



### Policy implications

There are clear opportunities for interventions aimed at supporting family bedtime routines that could have impacts on health throughout life.

- Health and other professionals implement checks during routine visits
- Health and lifestyle education in schools
- Campaigns to raise public awareness

*slide and that sounds a bit wishy-washy but I don't know if anybody else heard this a couple of weeks ago, the BBC had a whole day around sleep . Radio Four presenters were all walking around with their little monitors on and they'd all been laughing about having not got it wet in the shower and all this stuff in the morning. There was a whole day around sleep and the body clock, hardly anything about children. This was probably reflecting the great wealth of research that there is particularly relating to adults but far less about children. There wasn't anything, to the best of my knowledge , on children's' sleep.*

*I'll stop there. If you want any of the papers that I've shown you today then please just ask. (y.kelly@ucl.ac.uk)*