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Cohort Profile Update

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Cohort Profile Update: The China Jintan Child Cohort Study

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Abstract

The China Jintan Child Cohort study began in 2004 with 1656 pre-school participants and a research focus on studying the impact of environmental exposures, such as lead, on children's neurobehavioural outcomes. This population cohort now includes around 1000 of the original participants, who have been assessed three times over a period of 10 years. Since the original *IJE* cohort profile publication in 2010, participants have experienced a critical developmental transition from pre-school to school age and then adolescence. The study has also witnessed an increase in breadth and depth of data collection from the original aim of risk assessment. This cohort has added new directions to investigate the mechanisms and protective factors for the relationship between early health factors and child physical and mental health outcomes, with an emphasis on neurobehavioural consequences. The study now encompasses 11 domains, composed of repeated measures of the original variables and new domains of biomarkers, sleep, psychophysiology, neurocognition, personality, peer relationship, mindfulness and family dynamics. Depth of evaluation has increased from parent/teacher report to self/peer report and intergenerational family report. Consequently, the cohort has additional directions to include: (i) classmates of the original cohort participants for peer relationship assessment; and (ii) parental and grandparental measures to assess personality and dynamics within families. We welcome interest in our study and ask investigators to contact the corresponding author for additional information on data acquisition.

Key Messages

- Since its inception in 2004, the China Jintan Child Cohort Study has grown to include three waves of data collection and has followed its participants through the critical transition from childhood into adolescence; during this time, the study has investigated several early health risk factors of childhood development, with a particular focus on the relationship between environmental toxicant exposure, such as lead, and child neurocognitive and behavioural outcomes.
- The database has broadened in the breadth and depth of measures and now includes new domains such as psychophysiology, positive psychology, peer relationship, and intergenerational family dynamics; consequently, the study has evolved beyond risk assessment to an investigation of the social and brain mechanisms of early health risk factors.
- New waves of data collection allow for convergent analyses with the use of multiple informants and several different instruments to measure the same outcome.

What is the rationale for the new data collection?

The China Jintan (As of June 1, 2015, Jintan City became the Jintan District of Changzhou City, Jiangsu Province, China) Child Cohort Study is a longitudinal pre-school cohort[1,2] that was designed to study the impact of environmental exposure, such as lead, on children's neurobehavioural outcomes. Since the publication of our 2010 cohort profile, this cohort has expanded from a focus on risk assessment to understanding the mechanisms and protective factors for this lead-behaviour relationship, and from an original emphasis on environmental exposure to the inclusion of broad early health factors. These changes are guided by the 'Early Health Model' conceptual framework[3] and have been driven by the following three factors.

First, the new wave expanded from risk assessment to understanding the mechanism, protective factors and general early health factors, in child mental and physical health development. Specifically, there is increasing evidence that lead exposure may result in decreased IQ[4] and increased disruptive behaviour,[5] but the mechanism underlying this relationship in children is unclear. This new wave of data collection sought to elucidate the mediating mechanisms by measuring psychophysiology and other biomarkers. Furthermore, Wave 1 findings suggested that children with frequent breakfast consumption have lower blood lead concentrations (BLC) compared with their breakfast-skipping counterparts.[6] This suggested the need for a more comprehensive assessment of nutrition (e.g. food frequency questionnaire) as a potential protective factor in Wave 2 data collection. Furthermore, in order to understand factors that contribute to overall adolescent health, we included physiological assessments such as metabolic indicators (e.g. glucose, cholesterol, body mass index) and sleep patterns.

Second, as cohort participants transition from childhood into adolescence, they begin to experience more complex and salient peer relationships[6] which may contribute to their behaviour. Consequently, the cohort has evolved to include current classmates of the original cohort participants in order to assess these peer relationships. We also include measures of personality traits, such as positive psychology capital, in order to better understand behavioural development during this transition into adolescence.

Third, research has documented intergenerational transmission of personality traits and behaviours.[7,8] As a result, this new wave of data collection sought to include a cross-generational assessment of family dynamics and behavioural outcomes in the child, parent and grandparent generations.[9,10]

Given these rationales, the new waves of data collection provides a more comprehensive view of the complex process of child mental and physical health development, from risk assessment to understanding mechanisms to elucidating protective factors, as well as investigating the influence of peer and intergenerational factors.

What will be the new areas of research?

The new areas of research can be summarised into the following categories, with the rationale detailed below:

- inclusion of new domains of health factors;
- mechanistic investigation between health factors and neurobehavioural development;
- peer relationships between cohort participants and current classmates;
- cross-generational assessment of personality traits and behaviours.

Specifically, the new areas of research include biomarkers, sleep, psychophysiology, neurocognition, personality, peer relationships, mindfulness and family dynamics. As mentioned in our previously published cohort profile,[1] child development is complex and is the result of the interaction of

Table 1. Domains and measures assessed in Waves 1–3 of the China Jintan Child Cohort Study

Data collection encompassed eleven domains, and several dimensions of each domain were assessed using instruments presented here in parentheses.[a]

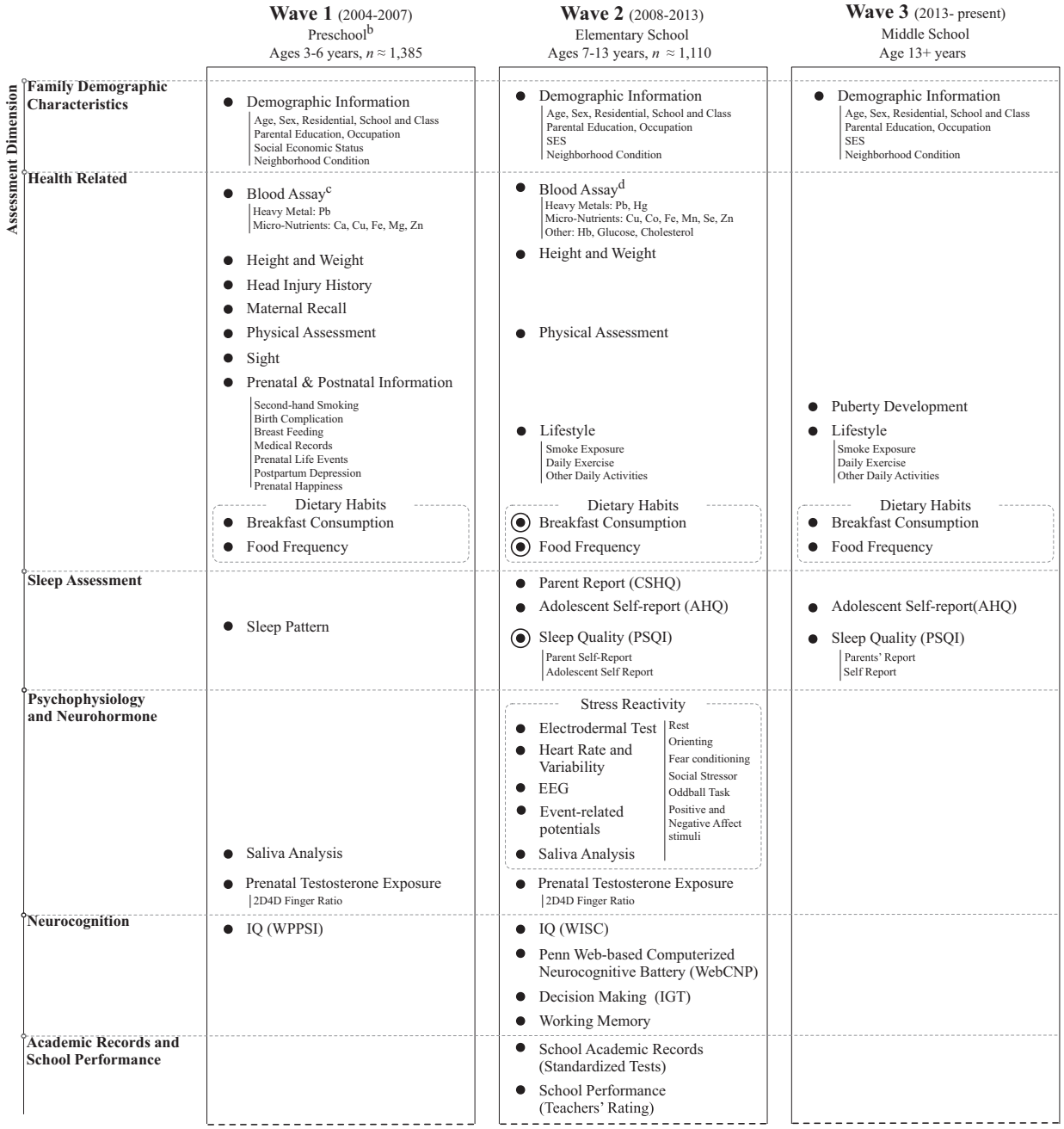

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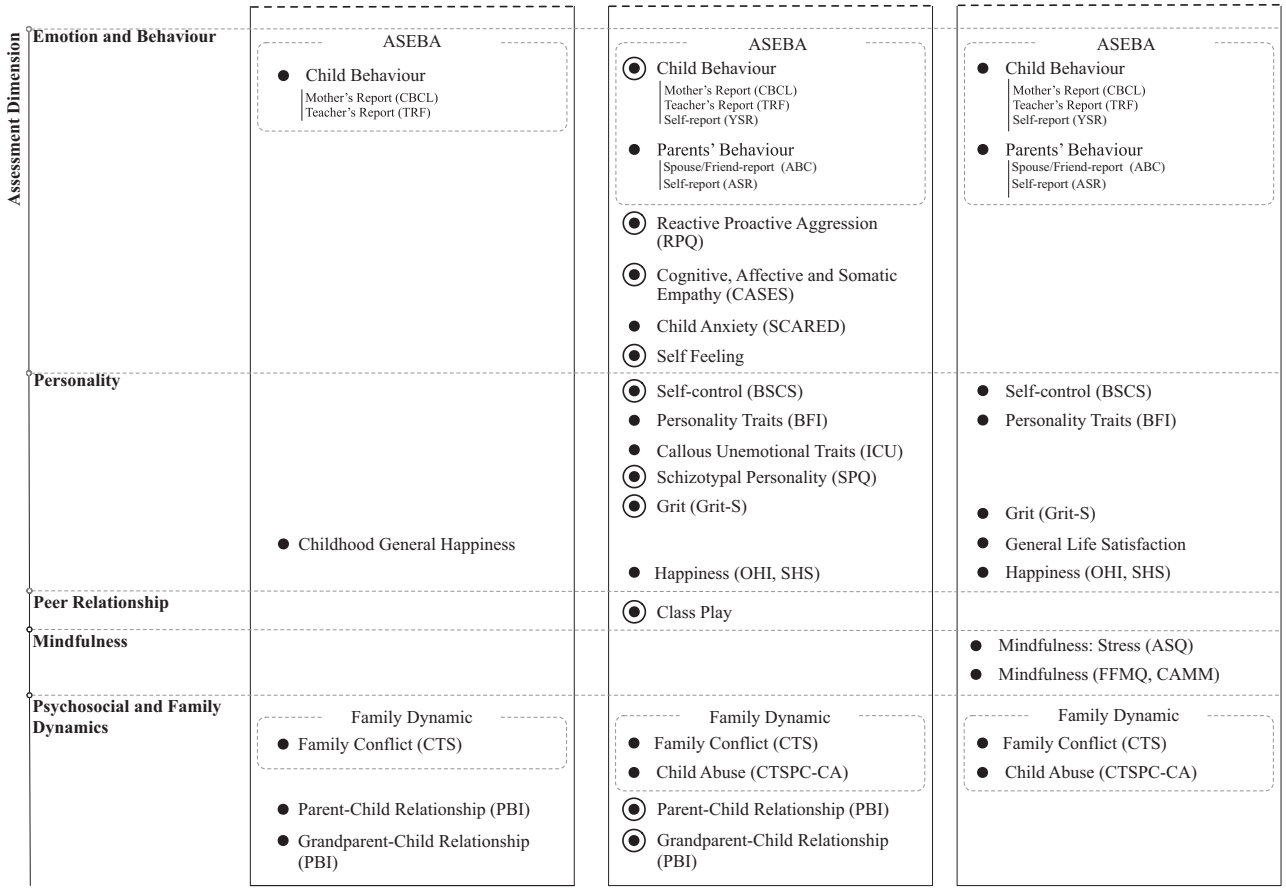
Table 1. Continued



All subjects were recruited in 2004 when they were in preschool. Chinese pre-schools are divided into junior (3–4 years old), middle (4–5 years old) and senior classes (5–6 years old).

● Measurement includes cohort only; ◉ Measurement includes cohort and classmates.

[a] Instrument Abbreviations: **AHQ**: Adolescent Health Questionnaire; **ASEBA**: Achenbach System of Empirically Based Assessment (**ABC**: Adult Behavior Checklist; **ASR**: Adult Self-Report; **CBCL**: Child Behavior Checklist; **TRF**: Teacher's Report Form; **YSR**: Youth Self-Report); **ASQ**: Adolescent Stress Questionnaire; **BFI**: Big Five Inventory; **BSCS**: Brief Self-Control Scale; **CAMM**: Child Acceptance and Mindfulness Measure; **CASES**: Cognitive, Affective, and Somatic Empathy Scale; **CSHQ**: Children's Sleep Habits Questionnaire; **CTS**: Conflict Tactics Scale (**CTSPC-CA**: Conflict Tactics Scale Parent-Child, form **CTSPC**); **FFMQ**: Five Facet Mindfulness Questionnaire; **Grit-S**: Short Grit Scale; **ICU**: Inventory of Callous Unemotional Traits; **IGT**: Iowa Gambling Task; **OHI**: Oxford Happiness Inventory; **PBI**: Parental Bonding Instrument; **PSQI**: Pittsburgh Sleep Quality Index; **RPQ**: Reactive-Proactive Aggression Questionnaire; **SCARED**: Screen for Child Anxiety Related Disorders; **SHS**: Subjective Happiness Scale; **SPQ**: Schizotypal Personality Questionnaire; **WebCNP**: Computerized Neuropsychological Testing System; **WISC**: Wechsler Intelligence Scale for Children; **WPPSI**: Wechsler Preschool and Primary Scale of Intelligence.

[b] In China, preschool is called kindergarten.

[c] For Wave 1, the blood test was conducted in 2004 for all preschool classes (junior, middle and senior) at the same time.

[d] For Wave 2, the blood test was conducted between 2011-2013, when the participants were in their last month of sixth grade of elementary school.

physical, social and psychological environments. Collectively, these domains allow us to assess risk and protective factors and the mechanisms underlying neurobehavioural outcomes. Details regarding instrumentation are presented in Table 1.

Biomarkers. In addition to blood lead, other heavy metals and nutrients have been linked to neurobehavioural outcomes.[11] Therefore, the new wave assessed an additional heavy metal (mercury) and micronutrients (selenium, cobalt, manganese). The new wave also measures fasting glucose and cholesterol levels to screen for metabolic disorders such as pre-diabetes and pre-hyperlipidaemia.

Sleep. Poor sleep and sleep disorders are highly prevalent in children, and like lead exposure, these conditions are associated with significant neurobehavioural impairment and other health outcomes such as increased fasting glucose (unpublished data). The cohort now employs several sleep questionnaires[12–17] to assess both child and parent sleep quality in order to study the developmental effects of sleep and intergenerational effects of sleep patterns.

Psychophysiology. This cohort has previously reported on the relationship between lead exposure and children's behavioural problems, but the mechanism underlying this association is unclear. Assessing psychophysiology helps to elucidate mechanisms of action between early health factors and neurobehavioural development. It was hypothesised, for example, that lead exposure can affect autonomic arousal that may predispose children to cognitive and emotional dysfunction, which in turn impacts behaviour.

Neurocognition. Previous measures of IQ have strong psychometric properties and are easy to use, but these measures were geared to assess general intelligence.[18–21] Neuropsychological tests are instead designed to target specific cognitive domains and are more sensitive in detecting the effects of neurological changes related to risk factors such as environmental exposure to lead. These tests include: (i) a computerised neuropsychological testing system, known as WebCNP™,[22] to assess neurocognitive functions such as abstraction, attention and motor speed; (ii) a working memory instrument;[23] and (iii) a risk-taking behaviour instrument.[24,25]

Personality. Recent research suggests that positive psychological capital is a protective factor in child development. In new waves of data collection, we collected self-reported measures of different aspects of personality[26–29] and positive psychological constructs, including happiness,[30,31] grit[32] and self-control.[29] We supplemented these measures with data collected from multiple informants, including their classmates, parents and teachers.

Peer relationships. As children grow into adolescence, social interaction becomes a more prominent feature of their daily lives and influences emotional and behavioural outcomes.[6] As a result, the cohort included peer relationship measurements through a class play instrument,[33] which is reported by the participants' classmates.

Mindfulness. Mindfulness is the state of non-judgemental attention to the present. It is a concept that has been implicated in child and adolescent behavioural development and as an aid to coping with stress.[34] As the participants of the cohort age and gain an awareness of themselves and their surroundings, this cohort piloted a study in 2014 in a small subsample to gauge their level of mindfulness and its associations with neurobehavioural outcomes.[35]

Family dynamics. Positive family dynamics, such as parental bonding, have been shown to serve as protective factors for children's neurobehavioural outcomes.[36,37] Conversely, negative family dynamics are considered risk factors for child development.[38,39] As a result, we measured parental bonding[9,10,40] and family conflicts[41,42] in the new wave of data collection. In order to gauge intergenerational effects of family dynamics,[7] we also included the grandparental generation in our surveys.

Who is in the cohort?

The Jintan Cohort is a pre-school cohort that initially recruited 1656 children in 2004. Briefly, the first phase of Wave 1 of data collection occurred in 2004–07, when the children were 3–6 years old and in pre-school; the second phase of Wave 1 of data collection occurred in 2008–10, when the children were 7–9 years old and in elementary school. During Wave 2 of data collection in 2011–13, the children were 11–13 years old and in their last few months of 6th grade, just prior to matriculation into middle school. Wave 3 data collection is ongoing. Descriptive statistics on several key biomarker measures are presented in Table 2 and descriptive statistics on behavioural and cognitive scores are presented in Table 3. As the children matriculated from pre-school, data collection for certain instruments expanded to include their new classmates in order to better understand the social implications of neurobehavioural development (e.g. peer relationships). Attrition data can be found in Figure 1. Complete data were available on 1385 (55% males) children in Wave 1, and 1110 (54% males) in Wave 2. The original and current cohort participants were compared on sex, residence, age, IQ and behaviour scores to assess bias due to attrition. Results of these analyses are shown in Table 4.

What has been measured?

All measures used in this cohort are listed in Table 1. These measures highlight several key features of this expanding cohort study. First, the scope of the study encompasses several new domains, including psychophysiology, neurocognition, personality, peer relationships, mindfulness and family dynamics, in addition to expanding previous domains of family demographic characteristics, health-related measures, sleep patterns and emotion and behaviour. Second, several instruments and multiple informants were used in each domain to provide a multi-informant perspective; questionnaire-based assessments were completed by the cohort children, their classmates, parents, grandparents and teachers (see Table 1). Third, we conducted follow-ups on several longitudinal measures[18,19,43–46] as the cohort participants transitioned from pre-school to school age to adolescence. These follow-ups capture the neurobehavioural changes occurring during this important period of physical, social and psychological growth. Fourth, we included intergenerational

Table 2. Descriptive statistics of key Wave 2 demographic and biomarker data from the China Jintan Cohort Study

		Sex		Total
		Male	Female	
Demographic Information				
Age[a]	N[b]	585	506	1091
	M (SD)[b]	11.89 (0.44)	11.83 (0.41)	11.86 (0.42)
Blood Assay				
Heavy Metal (μg/dL)				
Lead	N	595	513	1108
	M (SD)	3.21 (1.16)	3.01 (1.16)	3.12 (1.17)
	G (SD)	3.02 (1.17)	2.83 (1.16)	2.93 (1.04)
Manganese	N	154	151	305
	M (SD)	0.22 (0.11)	0.26 (0.18)	0.24 (0.25)
Micronutrient (μg/dL)				
Copper	N	594	514	1108
	M (SD)	97.60 (23.11)	95.36 (20.42)	95.63 (22.00)
Iron	N	592	514	1106
	M (SD)	113.20 (39.73)	113.55 (41.87)	113.36 (40.72)
Zinc	N	594	514	1108
	M (SD)	91.83 (22.32)	91.34 (22.34)	91.60 (22.32)
Cobalt	N	584	508	1092
	M (SD)	0.44 (0.52)	0.52 (0.70)	0.48 (0.61)
Selenium	N	595	513	1108
	M (SD)	145.56 (53.42)	145.48 (50.26)	145.52 (51.96)
Other Blood Tests				
Haemoglobin (g/dL)	N	553	488	1041
	M (SD)	13.28 (0.84)	13.10 (0.79)	13.20 (0.81)
Glucose (mmol/L)	N	568	497	1065
	M (SD)	5.18 (0.54)	5.08 (0.54)	5.13 (0.54)
Cholesterol (mmol/L)	N	568	497	1065
	M (SD)	3.98 (0.72)	3.96 (0.63)	3.98 (0.68)
Red Blood Cell (10^6/μL)	N	553	488	1041
	M (SD)	4.82 (0.34)	4.69 (0.33)	4.76 (0.34)

[a] Age of senior class is as of April 15th, 2011; age of middle class is as of April 15th, 2012; age of junior class is as of April 15th, 2013; total statistics is calculated with age attained with above the method(s). All above assessments were conducted when the children were at last semester of 6th grade.

[b] M (SD) stands for mean (standard deviation); G (SD) stands for geometric mean (standard deviation); N stands for sample size.

data in order to compare cross-generational effects of behaviour and lifestyle practices.

What has been found?

To date, 31 published journal articles have been derived from the Jintan Cohort on topics including baseline methodology,[1,2,10,46,47] sociodemographic variables,[48–52] environmental lead exposure,[4,5,48,53,54] child cognitive[4,20,21,55–59] and behavioural development[5,37,49,60–62] assessment, and cross-cultural comparisons.[63–67] A selection of these manuscripts, which have been integral in directing the new research focus, is presented in Table 5. These publications represent the multidisciplinary nature of data collection and a selection of key findings is listed below.

Lead exposure. The study has shown that in Wave 1, the mean of BLC was higher in boys than in girls and increased with age at the time of the blood lead test.[48] Compared with children with BLC <8 μg/dl, those with BLC ≥8 μg/dl scored 2–3 points lower in IQ and 5–6 points lower in school tests.[4] BLC, even at a mean of 6.4 μg/dl, was associated with increased risk of externalizing, internalizing and pervasive developmental problems.[5] The mechanisms behind these associations are unclear and as a result, further neurobiological testing is needed.

Nutrition. We have observed significant effects of nutritional status on health outcomes. Micronutrient (e.g. zinc and iron) deficiency was associated with increased behavioural problems.[49] Sufficient blood micronutrient concentrations, such as that of zinc, has been observed to be associated with good

Table 3. Participant cognition and behaviour scores in Wave 2 at around age 12 years

		Sex		Total
		Male	Female	
Cognitive Ability (IQ)				
	N	436	360	798
Verbal IQ	M (SD)	102.07 (12.17)	99.84 (11.59)	101.05 (11.94)
Performance IQ	M (SD)	106.96 (12.25)	103.51 (11.35)	105.41 (11.95)
Full-scale IQ	M (SD)	105.31 (11.94)	102.07 (11.61)	103.84 (11.88)
Behaviour (Youth Self-Report)				
	N	308	277	585
Internalizing	M (SD)	9.83 (6.96)	10.13 (7.00)	9.98 (6.97)
Externalizing	M (SD)	8.44 (6.67)	6.63 (5.38)	7.58 (6.16)

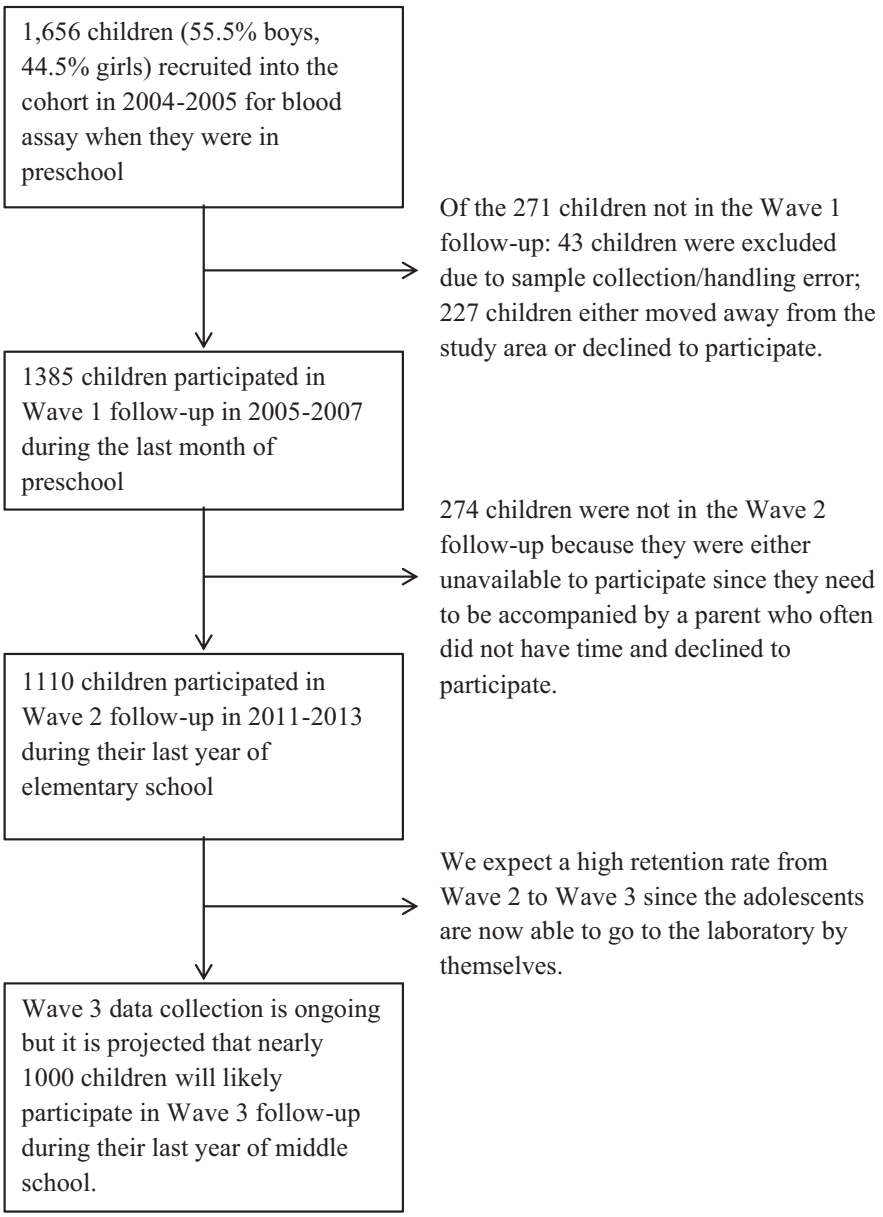


Figure 1. Participant attrition diagram for the China Jintan Child Cohort study.

Table 4. Comparison of key variables in the original cohort participants between those with and without follow up in Wave 2

Variable	Follow-up	Exited cohort	Test statistics	
	%	%	Chi-squared	*P*-value
Sex				
Male	53.2	59.6	4.216	**0.040***
Female	46.8	40.4		
Location				
Rural	20.7	19.6	0.404	0.817
Suburban	40.2	39.5		
City	39.1	40.9		
	Mean (SD)	**Mean (SD)**	**t test**	***P*-value**
Age	13.72 (0.89)	13.67 (0.91)	−1.06	0.291
IQ				
VIQ	104.26 (14.78)	102.95 (15.01)	1.372	0.170
PIQ	104.25 (14.64)	103.42 (16.41)	0.846	0.397
FIQ	104.46 (14.03)	103.29 (15.26)	1.266	0.206
Behaviour				
Parent report (CBCL)	33.83 (20.96)	32.88 (20.91)	0.736	0.462
Teacher report (TRF)	19.77 (17.14)	19.74 (16.73)	0.027	0.978

* Significant at $P < 0.05$.

sleep quality at different developmental stages in childhood.[68] Reduced breastfeeding consumption was also negatively associated with internalizing behaviour problems.[37] Nutrition in the form of frequent and regular breakfast consumption has been shown to be associated with lower BLC[53] and increased IQ performance[55] in pre-schoolers, suggesting that nutrition may serve as a protective factor in neurobehavioural development.

Behaviour. Prenatal risk factors for child behaviour problems have also been observed. Children of mothers exposed to second-hand smoking during pregnancy had higher scores for externalizing and total behaviour problems.[61] A positive association between a marker for prenatal testosterone exposure [i.e. the ratio of the length of the second finger digit relative to the fourth digit (2D4D)] and externalizing behaviour problems in children was also observed.[62]

Descriptive statistics for the new data collected

Selected preliminary analyses from the new wave of data collection on sleep and positive psychological capital are presented in Tables 6 and 7, respectively. As indicated in Table 6, sleep problems in children are prevalent and some sleep problems in the child are correlated with parental sleep problems (e.g. sleep latency, daytime dysfunction and subjective sleep quality). It was hypothesised that sleep problems may be influenced by early health risk factors. For example, we recently found that elevated BLC at ages 3–5 years was associated with increased risk for sleep disorders in early adolescence, including sleep disruption and/or insomnia.[69] This association may contribute to the overall negative effect of BLC on child behaviour. In addition, family dynamics also influenced child behaviour. Specifically, we found that early parental bonding reduced children's behavioural problems and that parental bonding was positively associated with bonding with grandparents among Chinese children (Table 7).[40]

What are the main strengths and weaknesses?

There are several strengths of the multiple-wave data collection model of this cohort. First, the cohort has now expanded to include the new direction of understanding the neurobiological mechanisms between environmental toxicants and children's neurobehavioural outcomes and the protective factors that may attenuate negative risk exposures. Second, the use of the same instruments allows for continuity in our longitudinal study and ease of comparison across years so that variability can be attributed to changes in the individual rather than changes in the instrument. Third, the study encompasses multiple dimensions to give greater depth to each outcome variable. The present cohort now includes specific physiological measures such as psychophysiology and neurohormonal data in order to gain a more focused understanding of the effects of environmental and social exposures. Fourth, the new waves of data collection have expanded from the original

Table 5. Key published findings from the China Jintan Child Cohort Study

Key variables	Findings	Link to new research Direction
Lead-related		
Behaviour	Blood lead levels are positively associated with behavioural and emotional problems among Chinese children.[5]	While lead exposure has been associated with decreased IQ and increased behavioural problems, the mechanisms of these relationships are unclear. These findings led to the need for 1) comprehensive neurobehavioural measurements (e.g. psychophysiology) as one of the new measurements in the new wave of data collection; 2) an investigation of nutrition as a protective factor due to the negative association between lead and various aspects of child nutrition (e.g. breakfast consumption, iron status, breastfeeding in infancy); and 3) further studies on the role of lead in sleep disturbance.
Breakfast consumption	Preschool children with frequent breakfast consumption have lower blood lead levels than their counterparts who skip breakfast.[53]	
Haemoglobin	Blood lead levels are negatively associated with haemoglobin concentrations in preschool children in China.[54]	
IQ	Blood lead levels are negatively associated with IQ and school performance in Chinese children.[4]	
Sleep	Early elevated blood lead levels are positively associated with sleep disturbance in preadolescence.[69]	
Sociodemographic factors	Sociodemographic factors (e.g. being male, increased age, presence of siblings), community conditions (e.g. living in crowded neighbourhoods), and parental factors (e.g. lower maternal education, paternal occupation, parental smoking) are positively associated with blood lead levels.[48]	
Behaviour		
Breastfeeding	Breastfeeding and active bonding are negatively associated with children's internalizing behaviour problems.[37]	These findings suggest there is a biological process underlying behavioural development. However, the social environment also plays a role and can interact with these biological processes. This cohort now seeks to understand the social determinants of behaviour by analysing peer relationships and family dynamics.
Head injury	Parent-reported mild head injury history positively associated and behavioural problems in children at 6 years.[60]	
Micronutrient	Low blood zinc and iron are positively associated with increased behaviour problems in pre-schoolers.[49]	
Testosterone exposure	2D:4D ratio, a marker for prenatal testosterone exposure, is positively associated with externalizing behaviour problems in children.[62]	
Tobacco exposure	Mother's environmental tobacco smoke exposure during pregnancy is positively associated with externalizing behaviour problems in children.[61]	
Nutrition		
Breakfast and IQ	Regular breakfast consumption is positively associated with IQ performance in kindergarten children.[55]	These findings suggest lifestyle choices, which are influenced by sociodemographic characteristics, can in turn influence various aspects of neurobehavioural development. These relationships suggest that nutrition should be explored further as a protective factor in child development.
Breastfeeding and sociodemographic	Social factors (e.g. city residents) and demographic determinants (e.g. parental education and professional occupational status) are associated with breastfeeding practices in South East China.[50]	
Haemoglobin and IQ	Haemoglobin status as a proxy for iron status is positively associated with performance IQ but not verbal IQ in Chinese pre-school children.[57]	
Obesity and sociodemographic	Prevalence of overweight and obesity in China has risen; maternal employment is negatively associated with overweight and obese status.[52]	
Sleep		
IQ and sleep problems	Sleep problems and fatigue are negatively associated with cognitive performance in Chinese kindergarten children.[58]	Findings provide new insights in understanding the role of sleep in the association between early health risk factors and neurobehavioural outcomes, along with the effect of nutritional factors on sleep quality. Further studies are being conducted to analyse cross-generational sleep patterns.
Micronutrient and sleep quality	Blood zinc concentrations at preschool age are predictive of later sleep quality in adolescence.[68]	
Positive psychology		
Parental bonding instrument	Psychometric properties of the Chinese version of the Parental Bonding Instrument.[10]	A strong familial relationship may have consequences on a child's positive psychology capital and as a result, the PBI instrument is used in current studies to analyse family dynamics.
Sociodemographic and intergenerational bonding	Child bonding relationships with parent and grandparent generations are positive correlated and associated with several sociodemographic factors.[40]	

Table 6. Descriptive statistics and correlations of adolescent and parent responses from the Pittsburgh Sleep Quality Index questionnaire

Sleep Domains[a]	Adolescent						Parent						Adolescent-Parent Correlation[d]
	N	Mean ± SD	Scores[b]				N	Mean ± SD	Scores[b]				
			0	1	2	3			0	1	2	3	
Sleep duration[c]	**971**	1.027 ± 0.872	26.3%	40.8%	26.5%	6.1%	**823**	0.276 ± 0.618	78.5%	18.5%	0.0%	3.0%	0.10
Sleep disturbances	**996**	0.901 ± 0.500	17.7%	74.9%	7.1%	0.3%	**842**	0.956 ± 0.433	11.3%	82.2%	6.4%	0.4%	0.00
Sleep latency	**1020**	0.915 ± 0.846	35.0%	43.9%	15.7%	5.4%	**837**	0.968 ± 0.790	29.7%	46.8%	20.3%	3.1%	0.22*
Day dysfunction due to sleepiness	**998**	0.908 ± 0.826	35.1%	43.1%	17.8%	4.0%	**845**	0.928 ± 0.747	29.7%	49.8%	18.5%	2.0%	0.14*
Sleep efficiency	**919**	0.188 ± 0.535	86.5%	9.5%	2.7%	1.3%	**827**	0.203 ± 0.528	84.4%	12.0%	2.5%	1.1%	−0.02
Subjective sleep quality	**997**	0.958 ± 0.765	27.5%	54.3%	15.4%	3.9%	**862**	0.836 ± 0.683	31.0%	56.3%	10.9%	1.9%	0.31*
Sleep medication use	**1022**	0.074 ± 0.360	94.9%	3.4%	1.0%	0.7%	**871**	0.054 ± 0.308	96.2%	2.8%	0.5%	0.6%	−0.09

[a] Sleep domains are measured by the Pittsburgh Sleep Quality Index (PSQI)[13] instrument, which consists of 19 items that are grouped into 7 subdomains.

[b] Scores of sleep domains (except sleep duration): 0 = best, 3 = worst; a higher score indicates worse sleep quality.

[c] Scores of sleep duration: 1) Adolescent[17]: 0: >9 hours; 1: 8–9 hours; 2: 7–8 hours; 3: <7 hours. 2) Parent[13]: 0: >7 hours; 1: 6–7 hours; 2: 5–6 hours; 3: <5 hours.

Table 7. Descriptive statistics of positive psychology questionnaires, reported by intergenerational informants

Measurements & Domains	Mean (Standard Deviation)				Correlation				
	Children[1]	Father[2]	Mother[3]	Grandparents[4]	r_{1-2}	r_{1-3}	r_{2-3}	r_{2-4}	r_{3-4}
Parent-Child Relationship[a]									
Care	-	13.83 (3.92)	14.31 (3.64)	14.87 (3.41)	-	-	0.491**	0.464**	0.400**
Indifference	-	4.74 (4.16)	4.16 (3.77)	4.44 (4.10)	-	-	0.613**	0.649**	0.561**
Overprotection	-	4.23 (3.98)	4.60 (3.54)	5.55 (4.23)	-	-	0.650**	0.643**	0.532**
Autonomy	-	12.59 (4.40)	11.83 (4.32)	13.29 (4.15)	-	-	0.571**	0.474**	0.406**
Grit[b]	3.14 (0.56)	3.38 (0.37)	3.34 (0.44)	-	0.123**	0.066	0.229**	-	-
Self Control	47.11 (6.38)	34.11 (5.35)	47.75 (7.39)	-	0.128**	0.007	−0.152**	-	-

** $P < 0.01$

[1–4] Superscripts are used to designate the correlation relationships. For example, r_{1-2} is the correlation between Children (1) and Father (2) questionnaire scores.

[a] Parent-child relationship is measured using the Parental Bonding Instrument (PBI),[9] which consists of 24 items and 4 sub-domains with each item rated from 0–3. A higher total score of each sub-domain indicates stronger bonding style. The sample size of father, mother and grandparents were 968, 974 and 910, respectively.

[b] The Grit Questionnaire[32] contains 12 items with each item rated from 1–5. A higher average score indicates higher grit. The sample size of children, father and mother were 655, 592 and 655, respectively.

[c] Range for short-term Self Control Questionnaire[29] contains 13 items with each item rated from 1–5. A higher score indicates better self-control ability. The sample size of children, father and mother were 610, 592 and 531, respectively.

cohort to include the participants' classmates and grandparents in addition to the participants themselves and their parents. This expansion allows for a better understanding of the complexity of children's neurobehavioural outcomes, as measured through peer relationships and family dynamics.

There are several limitations to this cohort design. First, the retrospective nature of the data collection relied on maternal recall for the earlier years of development, which may lead to recall bias. However, a similar recall vs medical record validation with the same instrument in a different study suggests that maternal recall measures are reliable for certain prenatal events.[70] Nevertheless, we will validate maternal recall with collected medical records. Another limitation is the lack of direct income data to measure socioeconomic status. Instead, we estimated socioeconomic status by utilising parental education, occupation, size of house and household, and living conditions to account for the variation in the make-up of the nuclear family. Third, like any cohort study, there are attrition

limitations since not everyone in the original sample can be followed up.

Can I get hold of the data? Where can I find out more?

The China Jintan Cohort welcomes interest and offers of collaboration. Applicants for data access should contact Dr Jianghong Liu [jhliu@nursing.upenn.edu], the principal investigator.

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Conflict of interest: Ethical approval was obtained from the Institutional Review Board at the University of Pennsylvania and Jintan Hospital. Patrick W Leung is the Hong Kong distributor of the ASEBA rating scales (e.g. CBCL, TRF, YSR, etc.) used in this study. None of the other authors declare any conflict of interest regarding the data and materials presented in this paper.

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