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A prospective cohort study to investigate parental stress and child health in low-income Chinese families: protocol paper

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ABSTRACT

Introduction Chronic stress has adverse effects on health. Adults and children from low-income families are subject to multiple sources of stress. Existing literature about economic hardship mostly focuses on either adults or children but not both. Moreover, there is limited knowledge on the relationship between parental generalised stress and child health problems. This study aims to explore the bidirectional relationship between parental stress and child health in Chinese low-income families and to identify other modifiable factors influencing this relationship.

Methods and analysis This prospective cohort study will sample 254 low-income parent–child pairs and follow them up for 24 months with assessments at three time points (baseline, 12 and 24 months) on parental stress, health-related quality of life (HRQOL) and child health and behaviour using both subjective measures and objective physiological parameters. This study will collect data using standardised measures on HRQOL and behaviours of children as well as on HRQOL, mental health and stress levels of parents along with physiological tests of allostatic load and telomere length. The mediating or moderating effect of family harmony, parenting style and neighbourhood conditions will also be assessed. Data will be analysed using latent growth modelling and cross-lagged path analysis modelling to examine the bidirectional effect of parental stress and child health over time. Mediation and moderation analysis will also be conducted to examine the mechanism by which the variables relate.

Ethics and dissemination This study was approved by the institutional review board of the University of Hong Kong—the Hospital Authority Hong Kong West Cluster, reference no: UW 16-415. The study findings will be disseminated through peer-reviewed publications and international conferences.

Trial registration number NCT03185273; Pre-results.

Strengths and limitations of this study

► This is a longitudinal study which allows for cause–effect relationships testing.
► The use of objective physiological parameters of children and parents will increase the reliability of the findings.
► This study will have only three measurement time points (baseline, 12 and 24 months).
► This study will use parent-proxy report of child health which may cause response bias.
► Study participants will be recruited from a community family support programme, which reduces the generalisability of our findings to other populations.

INTRODUCTION

Poverty is inextricably related to ill health; both can be transgenerational.[1] Dealing with financial hardship can cause substantial stress and negatively affect health. The Americans' Changing Lives Study which involved 3617 participants found that higher levels of parental stress were related to poorer self-rated health in parents.[2] Moreover, parental stress is a known risk factor for child maltreatment and family violence, both of which are increasing globally.[3] These early adverse events are detrimental to children's health and development. Recent research conducted in mainland China found that obesity prevalence was higher among children in wealthier families,[4] but the patterns were different in Hong Kong with higher rates of childhood obesity among lower income families.[4 5] Hong Kong, despite having a per capita gross domestic product of Hong Kong dollar (HK$) 273 550, has large income differences between rich and poor as reflected by a high Gini coefficient of 0.539 reported in 2016; approximately 20% of the population are living in poverty as defined by a monthly household income below half of the Hong Kong median.[6] It is widely accepted that population health tend to be worse in

societies with greater income inequalities, and hence low-income families in these societies are particularly at risk of health problems.[7] In our previous study, children from Hong Kong Chinese low-income families experienced poorer health and more behavioural problems than other children in the population at similar age.[8] Adults from these families also reported poorer health-related quality of life (HRQOL),[9] with 6.1% of the parents having a known history of mental illness and 18.2% of them reporting elevated level of stress. Therefore, health problems (mental or physical) resulting from poverty is a significant public health issue and their prevention is urgent.

Psychosocial effects of stress on adults and children

According to the Family Stress Model, parental stress impacts children's lives through disruptions in parenting skills and family relationships. The process starts from financial disadvantages causing pressure and stress which exacerbate family conflicts and increase poor parenting practices, ultimately leading to health and adjustment problems in children.[10] Moreover, family financial hardship has been associated with poorer social support and greater family tension,[11] which are known risk factors for mental health problems such as depression and anxiety. The resulting impairment in mental health disrupts interpersonal relationships among family members and has negative impact on parenting. Family conflicts and aggressive and neglectful parenting practices are particularly harmful to children's behavioural development, as conflicts and aggressive parenting behaviours can be observed and learnt by their children. Children growing up in such aggressive families may believe that family aggression is acceptable and thus become more likely to behave in aggressive or harmful ways toward others.[12 13] On the other hand, neglectful parents tend to show minimal physical affection towards their children, know little about child development and have incompetent caretaking skills[14] which can put their children at a higher risk for obesity and other diseases. These childhood problems might in turn intensify feeling of distress in parents. The pathway linking children's problems to parental stress has been underexplored and thus warrants further investigations. Furthermore, despite growing empirical support for the Family Stress Model, such model is not static and more empirical evaluations are needed to identify risk and protective factors for changing the family stress process.[15]

Parental stress and its biological effects

'Parental stress' refers to stress, defined as negative emotional experiences accompanied by predictable biochemical, physiological, cognitive and behavioural changes directed either towards altering the stressful event or accommodating to its effects, which parents experience in general term.[16] Parental stress results from child-rearing, and also from their social and environmental circumstances, responsibilities and everyday life such as insufficient social support, financial challenges and heavy parenting responsibilities.[17] Under chronic stressful conditions, excessive strain on the body can cause cumulative damages to physiological systems (eg, cardiovascular, metabolic, anthropometric, neuroendocrine and immune systems) which is often referred as allostatic load (AL).[18] Adults with high AL had been found to be more vulnerable to a number of physical, mental and behavioural disorders such as cardiovascular disease, depression and aggression.[19]

Biological effects of stress on child health

According to the 2007 Unicef report, child health is a multidimensional construct that involves material well-being, health and safety, education, family and peer relationships, subjective well-being, behaviours and lifestyles.[20] Previous studies showed that adverse childhood experiences such as chronic family financial stress can cause impairments in these health dimensions by disrupting various physiological systems in children.[21] Poor child health in turn limits a child's potential to interact successfully with the environments.[22] However, traditional AL markers cannot be easily measured in children because of the difficulty in blood sampling. To overcome this limitation, child health researchers have explored other non-invasive ways to collect biological samples from children for examination of objective physiological markers. An increasingly used method is to measure telomere length in children's buccal cells. Telomeres are essential components that protect the ends of chromosomes and shorten each time a cell divides. As a biomarker of cellular and biological ageing, telomere shortening is associated with a number of adverse health outcomes in adulthood. Previous studies on telomere length in children focused on severe environmental adversities in early childhood such as living in institutions[23] and prenatal tobacco exposure,[24] and demonstrated that the adverse living environment led to telomere shortening in exposed children. Children with family adversity had been found to have shorter telomeres and greater cortisol reactivity to stress,[25 26] which were associated with poorer health outcomes later in life.[27] At present, telomere length is regarded as a marker of stress exposure in children.[27] However, evidence on the long-term impact of telomere shortening since early childhood on health in adulthood is not yet available and warrants further research.

Relationship between parental stress and child health

Research evidence shows that maternal stressful experiences during pregnancy and in early postnatal period can lead to biological changes including neuroendocrine, epigenetic and neuroanatomical changes in children,[28] thereby increasing their risk for health and behavioural problems later in life. On the other hand, more health and behavioural problems in children may add to greater parental stress due to more caregiving responsibilities. This can further damage the parent–child relationship. A bidirectional relationship between specific form of parental stress such as parenting stress and child behaviours has
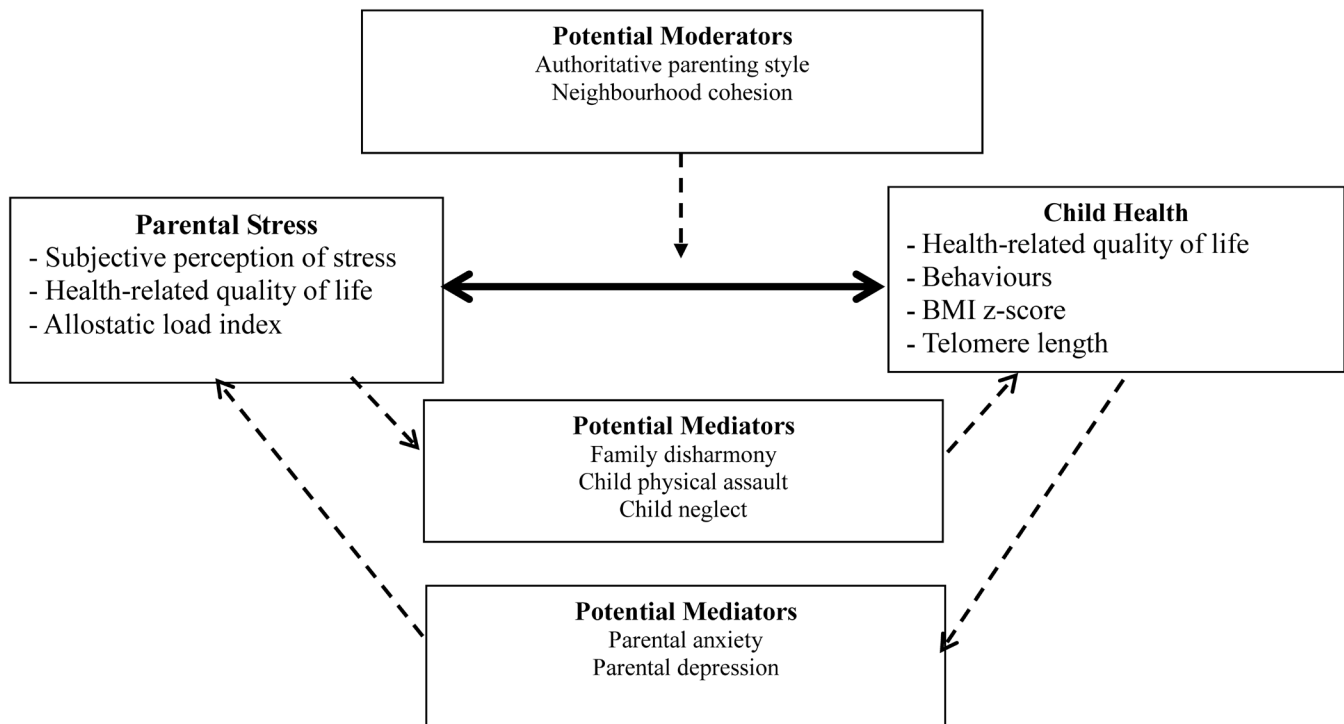
Figure 1 Study conceptual model. Potential confounders include baseline sociodemographic information (parental age and gender, child age and gender, household income, parental occupation and marital status), parental history of smoking, drinking and illicit drug use, parental and child history of comorbidities and child cognitive skills. BMI, body mass index.

been documented in some studies.[12 13] But little is known about the relationship between general form of parental stress and child health. In addition, previous research has been largely unidirectional, assuming that parental stress damages child health. The opposite direction that children influence parental stress is possible but scarcely studied.

Potential mediators and moderators

Despite the health risks of family financial hardship, certain individual and environmental factors might mitigate the negative consequences of growing up in a low-income household.[27] It has been posited that financial disadvantage is a risk factor for exposure to trauma and violence.[1] As illustrated in the Family Stress Model, low income can induce pressure and stress which is associated with abusive parenting.[29] Different meta-analyses on childhood abusive experiences, particularly physical abuse, have found significantly shorter telomeres and more physical and mental health problems in abuse victims.[30–32] The Family Stress Model also emphasises the importance of family relationship in children's lives. When financial pressure is high, financial hardship can exacerbate parental stress and increases conflicts and chaos in the family environment.[33] Children growing up in such hostile environment may have more behavioural problems[34 35] and a higher risk of obesity.[36] Furthermore, when children suffer health and behavioural problems, stressful parenting experiences

can inflict other negative emotional symptoms such as anxiety and depression which may further exacerbate distress in parents.[37]

Although living on a low income can be stressful, many stressed parents are still able to provide adequate care to their children.[38] There is evidence that appropriate parenting behaviours such as the use of reason rather than corporal punishment to discipline children can moderate the relationship between parenting stress and physical child abuse potential.[39] Many experts believe that authoritative parenting style is the most suitable parenting style in bringing up a child. Authoritative parenting practices are characterised by high responsiveness and reasonable demands such as setting concrete, age-appropriate expectations for children. Authoritative parenting style has been found to cause fewer behavioural and health problems in children.[40 41] In addition, neighbourhood characteristics might also function to protect children against the negative consequences of parental stress. In cohesive neighbourhoods where residents have a sense of trust and belongingness to each other, parents can seek support from their neighbours when they need help with childcare. Research show that more neighbourhood cohesion predicts better development and behavioural outcomes in children.[42] Despite the established benefits, neither authoritative parenting style nor neighbourhood cohesion has been studied as a moderator of the relationship between parental stress and child health.

The present study

This study aims to explore whether there is a bidirectional relationship between parental stress and child health, and to examine the mediators and moderators of the relationship between parental stress and child health. The study conceptual model is shown in figure 1. We hypothesise that there is a bidirectional relationship between parental stress and child health. We further hypothesise that family disharmony and child maltreatment are mediators of the association between parental stress and child health, whereas authoritative parenting style and neighbourhood cohesion are moderators of the association.

METHODS AND ANALYSIS
Study aims
- ► To estimate the prevalence of mild to high stress in low-income parents and the percentage of children with poorer HRQOL and more behavioural problems compared with the population norm.
- ► To examine the bidirectional relationship between parental stress and child health.
- ► To examine the correlation between changes in parental stress and changes in child health over time.
- ► To examine the associations between parents' perceived stress, HRQOL and AL on the body.
- ► To examine the associations between children's HRQOL, behaviours, body mass index (BMI) z-score and telomere length.
- ► To identify the moderators and mediators of the relationship between parental stress and child health.

Study design and setting

This is a prospective cohort study building on an existing cohort study (main cohort study) on the effectiveness of the Trekkers Family Enhancement Scheme funded by a philanthropic foundation in Hong Kong (Kerry Group Kuok Foundation (Hong Kong)).[9 43] This study will recruit parent–child pairs from low-income families and follow them up for 24 months with regular assessments on parental stress and child health using both subjective measures and objective physiological parameters. Additional data on HRQOL, family harmony, parenting style, neighbourhood cohesion and parental risk of child physical assault and neglect and mental health will also be collected at each assessment time point for testing mediating and moderating mechanisms between parental stress and child health. The baseline assessment will be conducted in 2016–2017 with follow-up assessments at 12 and 24 months.

Sample size calculations

To examine the association of factors with outcomes, several rules of thumb have been proposed for calculation of the required sample size based on the number of factors including (1) 10*(number of factors), (2) 50+number of factors and (3) 50+8*(number of factors).[44–46] A total of 16 factors including the potential confounders will be involved in the current study. A range from 66 to 178 subjects based on these three rules of thumb will be needed. A previous study showed that rule 3 is better than rules 1 and 2 at 80% power and 5% level of significance if a moderate effect size of 0.3 is assumed.[46] Therefore, considering an effect size of 0.3 and an attrition rate of 30%, a minimum sample size of 254 parent–child pairs is needed to detect a moderate correlation between changes in parental stress and changes in child health over time at 80% power and 5% level of significance.

Eligibility criteria

Participants are parent–child pairs from low-income families. Each parent–child pair consists of an index child (ie, the child agreeing to take part in cognitive assessment on recruitment) and his/her primary custodial parent (ie, the parent spending a majority of the time with the index child). The participants also need to satisfy the following inclusion criteria and without any exclusion criteria:

Inclusion criteria
- ► Family monthly household income does not exceed 75% of Hong Kong's median monthly household income.
- ► At least one parent and one child aged 6–18 years of the same family have given consent to participate in the main cohort study.[9 43]

Exclusion criteria
- ► Parents cannot speak or read Chinese.
- ► Children were born prematurely and/or with a congenital deformity.
- ► Neither parent is the primary caregiver of the child.

Recruitment

We will approach eligible participants in the main cohort study by telephone or during face-to-face sessions. A research assistant will inform eligible participants about the study and will obtain information and signed consent from those who express interest in study participation. After providing consent, the parent of each participating parent–child pair will spend 45–60 min to complete a set of structured and standardised questionnaires on parental mental health and HRQOL, parenting style, their children's well-being and behaviours, and family and neighbourhood environment. The questionnaires had been pilot tested in several low-income parents and minor editing was done to ensure the questionnaires are comprehensible to the respondents. The questionnaires will be administered in two separate batches (the first includes parent and child measures and the second includes family and neighbourhood measures). They will be administered by trained interviewers by face-to-face interview or telephone. If the parent cannot answer all the questionnaire items within one telephone interview or face-to-face session, the remaining unanswered items can be completed in next telephone interview session or self-completed at home and returned to the

Table 1 Measures, tools and time points for data collection

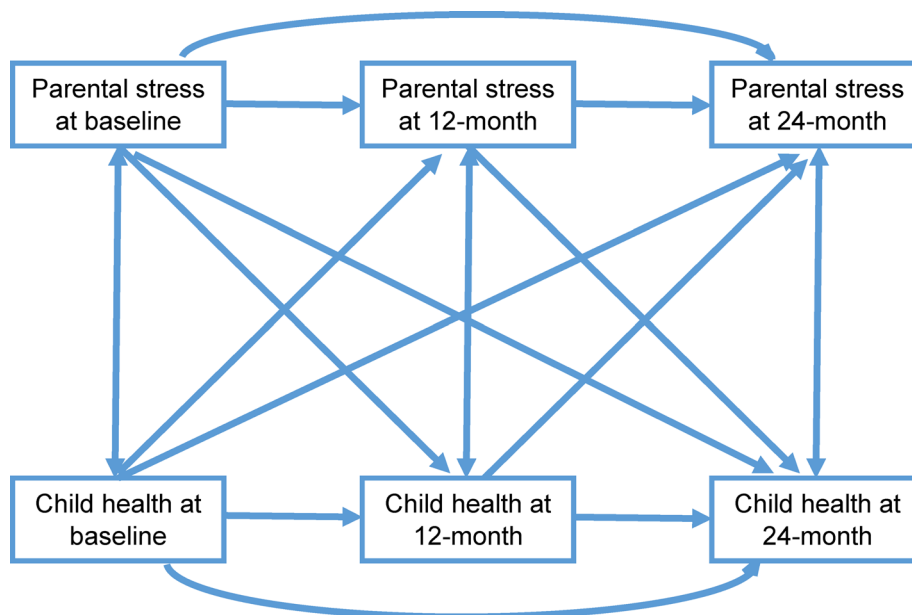|	Baseline		12-Month follow-up		24-Month follow-up	
	Child	Parent	Child	Parent	Child	Parent
Socioeconomic status						
Age	X	X				
Gender	X	X				
Marital status		X				
Education background		X				
Occupation		X				
Monthly household income		X		X		X
Immigration status		X				
Smoking/drinking/illicit drug use		X				
Health, cognitive and psychosocial assessments						
SDQ	X		X		X	
CHQ	X		X		X	
WISC-IV-HK-SF	X					
DASS		X		X		X
PHQ-9		X		X		X
SF-12v2		X		X		X
Comorbidities	X	X	X	X	X	X
Family and neighbourhood						
FHS-5				X		X
Authoritative parenting style subscale of PSDQ				X		X
NCES				X		X
Child physical assault and neglect subscale of CTSPC				X		X
Physical assessments						
Weight and height	X	X	X	X	X	X
Waist circumference and hip circumference	X	X	X	X	X	X
Blood pressure and heart rate	X	X	X	X	X	X
Laboratory tests						
Fasting blood glucose		X		X		X
Glycated haemoglobin		X		X		X
Lipid profile (total cholesterol, HDL and LDL cholesterol, triglyceride)		X		X		X
Telomere length	X				X	

CHQ, Child Health Questionnaire; CTSPC, Parent Child Conflict Tactics Scale; DASS, Depression Anxiety Stress Scales; FHS, Family Harmony Scale; HDL, high-density lipoprotein; LDL, low-density lipoprotein; NCES, Neighborhood Collective Efficacy Scale; PHQ, Patient Health Questionnaire; PSDQ, Parenting Style and Dimension Questionnaire; SDQ, Strength and Difficulties Questionnaire; SF-12v2: Short-Form Health Survey—the Second Version; WISC-IV-HK-SF, Wechsler Intelligence Scale for Children—Hong Kong (Short Form).

research office using our prepaid envelope. Physical examination on both the parent and child will include blood pressure, heart rate, weight, height and waist to hip ratio. Each child will have a buccal cell swab taken for measurement of their telomere length, and each adult will have a 15 mL of venous blood sample taken for fasting glucose test, glycosylated haemoglobin test and full lipid profile test.

Assessment procedure

This study will have three assessment waves: T1 baseline, T2 follow-up (12 months) and T3 follow-up (24 months). Table 1 shows the measurement and time points at which data will be collected.

Physical health data and biological samples will be collected by research nurses and research assistants during health assessment session held in community

Figure 2 Hypothesised cross-lagged path model predicting child health and parental stress from baseline to 24-month follow-up.

centres. Questionnaire data will be collected by trained interviewers during a telephone survey. To minimise attrition, a package of questionnaires and a sheet of instructions and equipment (ie, brushes) for swab taking at home may also be sent to parents on request. Parent–child pairs will be reimbursed HK$50 (US$6.4) for the baseline and HK$100 (US$12.8) for the 12-month and 24-month assessment.

Maintenance strategies

This study will recruit participants form the main cohort study, which aims to evaluate the effectiveness of a Family Enhancement Scheme for a group of low-income families by comparing the health outcomes of the intervention and control groups.[9] The intervention group has been enrolled in the Family Enhancement Scheme since 2012 and has agreed to take part in a 15-year project. These participants are engaged through regular contacts at various family enhancement interventions and are supportive of related research activities. Control families with similar socioeconomic background have been recruited by our research team and have agreed to be followed up for at least 5 years. To improve retention, free health assessments and incentives will be offered at each data collection time point. This strategy serves to attract low-income families who only have limited access to preventive health services, as most of these services are currently only offered in the private healthcare sector in Hong Kong. To maximise the sample size of this study, we will recruit all eligible parent–child pairs from intervention or control families of the Family Enhancement Scheme project. The potential grouping effect will be adjusted in the data analyses.

Study instrument and measures
Child health
Child Health Questionnaire—Parent Form 50 (CHQ-PF50)

CHQ-PF50 is a parent-proxy measure of children's physical and psychological well-being, with 50 items grouped into 12 multi-item subscales. The tool has good psychometric properties with Cronbach's alpha coefficient ranging from 0.66 to 0.94.[47] Its Chinese version has been used in local Chinese children.[43 48]

Strength and Difficulties Questionnaire (SDQ)

SDQ is a 25-item parent-completed questionnaire measuring children's behavioural issues. The SDQ, with five subscales, has been translated into traditional Chinese and tested with satisfactory reliability (Cronbach's alpha: 0.66–0.81) and validity in local children.[43 49]

Telomere length

DNA will be extracted from buccal epithelial cells. Telomere length will be measured by the method adapted from that originally published by Cawthon.[50] For each sample, the telomere length will be represented by the relative ratio of the telomere repeat copy number (T) to the single copy gene 36BA copy number (S). The T/S ratio will be determined by quantitative polymerase chain reaction using a 7900HT Thermocycler (Applied Biosystems). The quality of extracted DNA, as indicated by the value of A260/A280 ratio, will be determined by using the NanoDrop 2000c spectrophotometer (Thermo Scientific).

BMI z-score

As BMI (calculated as weight/height^2) changes rapidly in childhood, and growth patterns differ between boys and girls, BMI will be converted to z-score based on the

international child growth reference.[51] This method allows for direct comparison of BMI and its changes across different ages and genders.

Parental health
Mental health
Depression Anxiety Stress Scale (DASS) has three subscales, each with seven items rating the severity/frequency of symptoms of stress, anxiety and depression, respectively. The total score of each dimension can be categorised as 'normal', 'mild', 'moderate', 'severe' and 'extremely severe', according to the DASS manual.[52] DASS also has well-established psychometric properties[52] and been validated in Chinese population (Cronbach's alpha: 0.80–0.82).[53]

Quality of life
The Short-Form 12 Health Survey—Version 2 (SF-12v2) is a 12-item quality-of-life assessment instrument, producing 8 subscales and 2 composite summary scores. The Chinese version of SF-12v2 has been validated and normed in local Chinese population with Cronbach's alpha coefficient ranging from 0.60 to 0.89.[43 54 55]

AL Index
A review of literature has identified a set of physiological parameters that can reflect AL and yet be conveniently measured, including blood pressure, heart rate, BMI, waist to hip ratio, lipid profile, fasting glucose and glycosylated haemoglobin.[18] This set of physiological parameters will be measured and included in the calculation of AL Index in this study. An index score of AL is calculated by summing the number of parameters that fall into the abnormality category defined by local clinical practice guidelines.

Screening for depression
Patient Health Questionnaire-9 (PHQ-9) is used to screen for depression in parents. The Chinese version of PHQ-9 has been validated and used in previous local studies (Cronbach's alpha: 0.82).[43]

Family and neighbourhood environment
Family environment
The Chinese version of Family Harmony Scale-5 (FHS-5) will be used to measure family harmony (Cronbach's alpha: 0.92).[56] Parental risk of physically abusing and neglecting children as well as their parenting style will also be assessed with the Child Physical Assault and Neglect Subscale of the Parent Child Conflict Tactics Scale (CTSPC) (Cronbach's alpha: 0.77–0.88)[57] and the Authoritative Parenting Style Subscale of the Parenting Style and Dimension Questionnaire (PSDQ) (Cronbach's alpha: 0.71–0.97),[58 59] respectively.

Neighbourhood
The Chinese version of Neighborhood Collective Efficacy Scale (NCES) is a 10-item scale, with 5 items each on informal social control and social cohesion (Cronbach's alpha: 0.63).[60]

The following sociodemographic characteristics will be considered to be potential confounding factors on the basis of their potential associations with parental stress and child health: household income, children's age and gender, and parental age and gender, education level, occupation, marital status and immigration status. Parental history of smoking, drinking and illicit drug use, occupation and marital status, comorbidities of parents and children, and household income will be recorded at baseline and follow-ups. The cognitive abilities of the child from each household were assessed by a clinical psychologist using the Wechsler Intelligence Scale for Children Fourth Edition—Hong Kong (Short Form) (WISC-IV-HK-SF) at the time of enrolment into the main cohort study. Data on such estimation of IQ of the children will be retrieved and used as a confounder in the study.

Data processing and analysis
Descriptive statistics will be used to summarise the characteristics of parents and children at baseline and each follow-up time point. Parents with a cut-off score of ≥15 in stress dimension of DASS will be considered as having at least mild stress as referenced by the DASS manual.[52] Missing data will be handled using full information maximum likelihood in the estimation of path models. This method is robust against biases from data missing at random. Latent growth modelling will be conducted to obtain how the parental stress and child health change over times. The bidirectional relationship between parental stress and child health over times will be determined using the cross-lagged path model (figure 2).[13] Mediation and moderation analysis will also be conducted to map out the mechanism by which the variables relate. All analyses will control for a range of confounding factors with the following variables as outcomes/mediators/moderators:

Primary exposures/outcomes
► Child CHQ General Health Perceptions subscale score
► Parental DASS Stress subscale score

Secondary outcomes
► Child SDQ Total Difficulty score
► Child DNA telomere length
► Child BMI z-score
► Parental AL Index
► Parental SF-12v2 HRQOL scores

Mediators of the relationship between parental stress and child health
► Parental mental health: depression (PHQ-9 score), DASS Depression and Anxiety subscale score
► Family disharmony measured by FHS-5
► Child physical assault and neglect potential measured by the Physical Assault and Neglect Subscale of the CTSPC

Moderators of the relationship between parental stress and child health

► Authoritative parenting style measured by the Authoritative Parenting Style subscale of the PSDQ
► Neighbourhood cohesion measured by NCES

Potential confounders include sociodemographic information (parental age and gender, child age and gender, household income, parental occupation and marital status), parental history of smoking, drinking and illicit drug use, parental and child history of comorbidities and child cognitive skills. All statistical analyses will be performed using IBM SPSS Statistics and Mplus. All significance tests will be two tailed, and those findings with a P value less than 0.05 will be considered statistically significant.

DISCUSSION

Chronic exposure to stressors and dangers of poverty can have a detrimental impact on the health of parents and their children. It is important to mitigate the effect of poverty through protective mechanisms, the development of which should be guided by empirical evidence. Although it is known that poverty and poor health are linked with each other, the present research, with an aim to elucidate the relationship between parental stress and child health in low-income families, will give further insights into the possible vicious cycle of ill health between parents and children, an aspect that is often overlooked. For example, the question of whether changes in parental stress correlate with changes in child health over time and its magnitude will be investigated. The result will inform various stakeholders about the potential of improvement through interventions on parental stress and child health.

In addition to parent-proxy reports of children's general health, measurement of telomere length in children will provide more convincing evidence on the biological health of the children at cellular level. We will also measure child BMI z-score which is a recognised indicator of child health to reflect the growth of the children. The results will help to establish the robustness of assessing child general health using parent-proxy report and/or telomere length as a measure of child health for either clinical use or future research purposes. Moreover, parental AL Index will also be studied in this research. The index represents the sum of physiological dysregulations in the body of an individual in response to chronic stressful situation prior to onset of medical illnesses, and is measured by a combination of biomarkers of health such as adiposity, blood pressure and plasma glucose level. The total 'stress load' is presented as a composite score, the AL Index, which predicts morbidity and mortality.[19] These results will provide the public with evidence of the biological impact of perceived stress on parents.

Furthermore, this study will examine the mediators of the parent–child health relationship. The findings would inform healthcare providers and policy-makers on the potential targets for intervention to improve both parental and child health (eg, interventions for intimate partner abuse and family disharmony, or enhanced care for depression and anxiety). On the other hand, moderation analysis will focus on authoritative parenting style and neighbourhood cohesion. These two factors were selected because of their potentials for improvement through interventions, for example, parenting skill training and community fun day, which deem feasible and may benefit the whole community. For policy-makers, the results could be useful for informing the design of a holistic approach to address children's health issues and parental stress. Ultimately, targeted interventions at risk factors identified by this study can be developed at the community level to improve the health of parents and children of low-income families.

This study has several strengths and limitations. Some children in this study are quite young and may not be able to give reliable information on their own health status. Children's HRQOL and behaviours will therefore be proxy reported by their parents. Despite this limitation, this study assesses participants' perceived health status and uses objective measures such as telomere length measurement and AL Index calculation to give a holistic view of the health conditions of study participants. The inclusion of both objective and participant-reported outcomes can increase the reliability of the findings by reducing response bias. In addition, this study provides longitudinal data which make it possible to examine cause–effect relationships between variables. The results will be useful to advance our understanding of the linkage between parental and child health. However, this study focuses on a subgroup of low-income families in Hong Kong which is not a population-representative sample and hence the findings may not be generalisable to other populations. Moreover, in order to reduce the respondent burden (and improve the response rate) in the completion of a large number of questionnaires, the outcomes will be measured only at three time points. Further follow-up assessment should be conducted if resources are available.

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