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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-018792
Article Type:	Protocol
Date Submitted by the Author:	21-Jul-2017
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Keywords:	Parental stress, Child health, Health-related quality of life, Bidirectional relationship, Low-income families

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Manuscripts

Title

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. To date, much of the research on the health effect from chronic stress among low-income families focused on either adults or children but there is limited knowledge on the interaction among stress, parental health and child health problems. This prospective cohort study aims to explore the bidirectional relationship between parental stress and health-related quality of life (HRQOL) and child health and behaviors in Chinese low income families.

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 3 time points (baseline, 12-, and 24-months) on parental stress, HRQOL, and child health and behavior using both subjective measures and objective physiological parameters. This study will collect data using standardized measures on HRQOL and behaviors of children as well as 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 neighborhood conditions will also be assessed. Data will be analyzed by latent growth modeling and cross lagged path model to examine the relationship between changes in parental health and changes in child health. 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 number: UW 16-415. The study findings will be disseminated through peer-reviewed publications and international conferences.

Trial registration number ClinicalTrials.Gov: NCT03185273

Strength and limitations of this study

- This study will advance the knowledge on whether and how parental stress, mental health and HRQOL interact with child health and behavior over time among low-income families.
- Family harmony, parenting style and neighborhood cohesion will be assessed to determine their effect on parental and child health.
- Findings will promote a system approach in the health care policy and service provision for low-income families.
- Study participants will be recruited from a community family support programme, which reduces the generalizability of our findings to other populations.
- This study will use parent-proxy report of child HRQOL and behaviors which may cause response bias.

Introduction

Poverty is inextricably related to ill health; both can be trans-generational.¹ Hong Kong, despite having a per-capita-gross-domestic-product (GDP) of HK\$273,550, has a high Gini coefficient of 0.537 reported in 2011; approximately 20% of the population are living in poverty as defined by a monthly household income below half of the Hong Kong median.² 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

Economic hardship has been associated with poorer social support and greater family tension,³ predisposing individuals and families to mental health problems such as depression and anxiety. Poor mental health may disrupt parenting quality and interpersonal relationships among family members; family conflicts and maladaptive parenting practices may in turn place their children at an increased risk of poor health outcomes^{4 5} and jeopardize the children's opportunity to receive adequate cognitive and psychosocial resources. Without adequate care and guidance from parents, children from low-income families are prone to develop weight problems and problem behaviors, such as truancy and disobedience. These childhood problems might also intensify symptoms of stress in parents. In our previous study, children from Chinese low-income families also experienced poorer health and more behavioral problems than other children in the population at similar age.⁶

Parental stress and its biological effects

"Parental stress" refers to stress, defined as negative emotional experiences accompanied by predictable biochemical, physiological, cognitive, and behavioral changes directed either towards altering the stressful event or accommodating to its effects, which parents experience in general term.⁷ Parental stress does not only result from child-rearing, but also from their social and environmental circumstances, responsibilities, and everyday life such as the presence or absence of social support, economic challenges and parenting responsibilities, which influences parents' well-being and mental health.⁸ Under chronic stressful conditions, excessive strain on the body can cause cumulative damages to physiological systems (e.g. cardiovascular, metabolic, anthropometric, neuroendocrine and immune systems) which is often referred as allostatic load (AL).⁹ Adults with high AL had been found to be more vulnerable to a number of physical, mental and behavioral disorders

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3 such as cardiovascular disease, depression and aggression.¹⁰
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6 *Biological effects of stress on child health*

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8 “Child health” is the extent to which individual children (or groups of children) are able
9 or enabled to i) Develop and realize their potential, ii) Satisfy their needs, and iii) Develop
10 the capacities that allow them to interact successfully with their biological, physical and
11 social environments.¹¹ According to the 2007 United Nations International Children's
12 Emergency Fund (UNICEF) report, child health can be described in six dimensions according
13 to the: material well-being, health and safety, education, family and peer relationships,
14 subjective well-being, behaviors and lifestyles.¹² Animal and human studies have shown that
15 child health outcomes later in life were related to early caregiving experiences through
16 physiological stress responses.¹³ In children, some traditional AL markers cannot be easily
17 measured because of difficulty in blood sampling. Telomeres are essential components that
18 protect the ends of chromosomes and shorten each time a cell divides. As a biomarker of
19 cellular and biologic aging, telomere shortening is associated with a number of adverse health
20 outcomes in adulthood. Previous studies on telomere length in children focused on severe
21 environmental adversities in early childhood such as living in institutions¹⁴ and prenatal
22 tobacco exposure,¹⁵ and demonstrated that adverse living environment led to telomere
23 shortening in exposed children. Children with family adversity had been found to have
24 shorter telomeres and greater cortisol reactivity to stress,^{16 17} which were associated with
25 poorer health outcomes later in life.¹⁸ At present, telomere length is regarded as a marker of
26 stress exposure in children.¹⁸ However, evidence on the long term impact of telomere
27 shortening since early childhood on health in adulthood is not yet available and warrants
28 further research.
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43 *Relationship between parental stress and child health*

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45 Previous study confirmed that stressful experiences during maternal pregnancy and
46 early postnatal period might manifest as biological changes in children,¹⁹ which increased
47 their vulnerability to health and behavioral problems later in life. A bidirectional relationship
48 between parenting stress and child behaviors had also been documented in some studies, but
49 these studies focused on stress resulting from parenting.^{4 5} It remains unclear whether
50 generalized stress in parents is related to child health in a bidirectional or unidirectional way.
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56 *Potential mediators and moderators*

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3 Since not all children from low-income families develop problematic behaviors and/or
4 emotions, there may be certain factors that can protect a child from the negative
5 consequences of growing up in a low-income household.¹⁸ It has been posited that economic
6 disadvantage is a risk factor for exposure to trauma and violence.¹ Our previous study
7 showed that maternal mental quality of life mediated the association between intimate partner
8 abuse against mothers and their children's behaviors and quality of life.²⁰ Family disharmony
9 and child maltreatment can therefore be potential intermediate variables contributing to the
10 association of parental stress with child health particularly among low-income families. On
11 the other hand, researches had found that an authoritative parenting style and neighborhood
12 cohesion might have protective benefits on these children.^{16 21}

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21 This study aims to explore whether there is a bi-directional relationship between
22 parental stress and child health, and to examine the mediators and moderators of the
23 relationship between parental stress and child health. The study conceptual model is shown in
24 Figure 1. We hypothesize that there is a bi-directional relationship between parental stress
25 and child health. We further hypothesize that family disharmony and child maltreatment are
26 intermediate variables contributing to the association of parental stress with child health
27 particularly among low-income families, whereas authoritative parenting style and
28 neighborhood cohesion has protective benefits on these children.

33 34 35 36 **Methods and analysis**

37 38 **Study aims**

- 39 ● To examine the relationship between parental stress and child health.
- 40 ● To evaluate the stress of parents as indicated by their subjective perception of mental
41 health, quality of life and allostatic load on the body.
- 42 ● To evaluate the health of children as indicated by their well-being, behaviors, body
43 mass index (BMI) z-score and telomere length.
- 44 ● To examine the correlation between changes in parental stress and changes in child
45 health over time.
- 46 ● To identify the moderators and mediators of the relationship between parental stress
47 and child health.

48 49 50 51 52 53 54 55 **Study design and setting**

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3 This is a prospective cohort study building upon an existing cohort study (main cohort
4 study) on the effectiveness of the Trekkers Family Enhancement Scheme funded by a
5 philanthropic foundation in Hong Kong (Kerry Group Kuok Foundation (Hong Kong)
6 Limited).^{22,23} This study will recruit parent-child pairs from low-income families and follow
7 them up for 24 months with regular assessment on parental stress and child health using both
8 subjective measures and objective physiological parameters. Additional data on health-related
9 quality of life (HRQOL), family harmony, parenting style, neighborhood cohesion, and
10 parental risk of child physical assault and neglect and mental health will also be collected at
11 each assessment time point for testing mediating and moderating mechanisms between
12 parental stress and child health. The baseline assessment will be conducted in 2016-17 with
13 follow-up assessments at 12 and 24 months.
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22 **Ethics**

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24 The ethics of this study has been approved by the institutional review board of the
25 University of Hong Kong – the Hospital Authority Hong Kong West Cluster, Reference
26 number: UW 16-415.
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30 **Sample size calculations**

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32 To evaluate the association of factors with outcomes, several rules of thumb have been
33 proposed for calculation of the required sample size based on the number of factors including
34 (i) $10 \times (\text{number of factors})$, (ii) $50 + \text{number of factors}$ and (iii) $50 + 8 \times (\text{number of}$
35 $\text{factors})$.²⁴⁻²⁶ A total of 16 factors including the potential confounders will be involved in the
36 current study. A range from 66 to 178 subjects based on these three rules of thumb will be
37 needed. A previous study showed that rule (iii) is better than rule (i) and (ii) at 80% power
38 and 5% level of significance if an moderate effect size of 0.3 is assumed.²⁶ Therefore,
39 considering an effect size of 0.3 and an attrition rate of 30%, a minimum sample size of 254
40 parent-child pairs is needed to detect a moderate correlation between changes in parental
41 stress and changes in child health over time at 80% power and 5% level of significance.
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50 **Eligibility Criteria**

51 Participants are parent-child pairs from low-income families who satisfy the following
52 inclusion criteria and without any exclusion criteria:
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55 *Inclusion criteria:*

- 56 • Family monthly household income does not exceed 75% of Hong Kong's median
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3 monthly household income; and

- 4 • At least one parent and one child aged 6 to 18 years of the same family have given
5 consent to participate in the main cohort study.^{22 23}
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8 *Exclusion criteria:*

- 9 • Parents cannot speak or read Chinese;
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11 • Children were born prematurely and/or with a congenital deformity; and
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13 • Neither parent is the primary caregiver of the child.
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16 **Recruitment**

17 We will approach eligible participants in the main cohort study by telephone or during
18 face-to-face sessions. Information and consent for each parent-child pair will be obtained from
19 those who express interest in study participation. After providing consent, the parent of each
20 parent-child pair will complete a set of structured questionnaires on parental mental health
21 and HRQOL, parenting style, neighborhood cohesion, and their children's well-being and
22 behaviors. Physical examination on both the parent and child will include blood pressure,
23 heart rate, weight, height, and waist-to-hip ratio. Each child will have a buccal cell swab and
24 each adult will have a venous blood sample taken.
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32 **Assessment procedure**

33 This study will have three assessment waves: T1 Baseline, T2 follow up (12 months),
34 and T3 follow up (24 months). Table 1 shows the measurement and time points at which data
35 will be collected.
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38 Physical health data and biological samples will be collected by research nurses and
39 research assistants during health assessment sessions held in community centers.
40 Questionnaire data will be collected by trained interviewers during a telephone survey. To
41 minimize attrition, a package of questionnaires and a sheet of instructions and equipment (i.e.
42 brushes) for swab-taking at home may also be sent to parents upon request. Parent-child pairs
43 will be reimbursed HK\$50 (US\$6.4) for the baseline and HK\$100 (US\$12.8) for the
44 12-month and 24-month assessments.
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52 **Maintenance Strategies**

53 This study will recruit participants from the main cohort study, which aims to evaluate
54 the effectiveness of a Family Enhancement Scheme for a group of low-income families by
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3 comparing the health outcomes of the intervention and control groups.²³ The intervention
4 group has been enrolled in the Family Enhancement Scheme since 2012 and has agreed to
5 take part in a 15-year project. These participants are engaged through regular contacts at
6 various family enhancement interventions and are supportive of related research activities.
7 Control families with similar socio-economical background have been recruited by our
8 research team and have agreed to be followed up for at least 5 years. To improve retention,
9 free health assessments and incentives will be offered at each data collection time point. This
10 strategy serves to attract low-income families who only have limited access to preventive
11 health services, as most of these services are currently only offered in the private healthcare
12 sector in Hong Kong.
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21 **Study instrument and measures**

22 Child health

23 Child Health Questionnaire – Parent Form 50 (CHQ-PF50) is a parent proxy measure of
24 children’s physical and psychological wellbeing, with 50 items grouped into 12 multi-item
25 subscales. Its Chinese version has been shown to have good psychometric properties in local
26 Chinese children.^{22 27}
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32 Strength and Difficulties Questionnaire (SDQ) is a 25-item parent-completed questionnaire
33 measuring children’s behavioral issues. The SDQ, with 5 subscales, has been translated into
34 traditional Chinese and tested with satisfactory reliability and validity in local children.^{22 28}
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39 Telomere length: DNA will be extracted from buccal epithelial cells. Telomere length will be
40 measured by the method adapted from that originally published by Cawthon.²⁹ For each
41 sample, the telomere length will be represented by the relative ratio of the telomere repeat
42 copy number (T) to the single copy gene 36BA copy number (S). The T/S ratio will be
43 determined by quantitative polymerase chain reaction (qPCR) using a 7900HT Thermocycler
44 (Applied Biosystems). The quality of extracted DNA, as indicated by the value
45 of A260/A280 ratio, will be determined by using the NanoDrop 2000c spectrophotometer
46 (Thermo Scientific).
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53 Body Mass Index (BMI) z-score: As BMI (calculated as $\text{weight}/\text{height}^2$) changes rapidly in
54 childhood, and growth patterns differ between boys and girls, BMI will be converted to
55 z-score based on the international child growth reference.³⁰ This method allows for direct
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3 comparison of BMI and its changes across different ages and genders.
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6 Parental health

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8 Mental health: Depression Anxiety Stress Scale (DASS) has 3 subscales, each with 7 items
9 rating the severity/frequency of symptoms of stress, anxiety and depression respectively.
10 DASS also has well-established psychometric properties³¹ and been validated in Chinese
11 population.³² In addition, Patient Health Questionnaire – 9 (PHQ-9) will be used to screen for
12 depression in parents. The Chinese version of PHQ-9 has been validated and used in previous
13 local studies.²²
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19 Quality of life: The SF-12 Health Survey-Version 2 (SF-12v2) is a 12-item quality of life
20 assessment instrument that covers 8 subscales and 2 summary components. The Chinese
21 version of SF-12v2 has been validated and normed in local Chinese population.^{33 34}
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26 Allostatic load index: A review of literature has identified a set of physiological parameters
27 that can reflect AL and yet be conveniently measured, including blood pressure, heart rate,
28 BMI, waist-to-hip ratio, lipid profile, fasting glucose and glycosylated haemoglobin.⁹ An
29 index score of AL is calculated by summing the number of parameters that fall into the
30 “highest” risk quartile defined by local clinical practice guidelines.
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36 Screening for depression: Patient Health Questionnaire – 9 (PHQ – 9) is used to screen for
37 depression in the parent. The Chinese version of PHQ-9 has been validated and used in
38 previous local studies.²²
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41 Family and neighborhood environment

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43 Family environment: The Chinese version of Family Harmony Scale – 5 (FHS-5) will be
44 used to measure family harmony.³⁵ Parental risk of physically abusing and neglecting
45 children as well as their parenting style will also be assessed with the Child Physical Assault
46 and Neglect subscale of the Parent Child Conflict Tactics Scale (CTSPC)³⁶ and the
47 Authoritative Parenting Style subscale of the Parenting Style and Dimension Questionnaire
48 (PSDQ),³⁷ respectively.
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55 Neighborhood: The Chinese version of Neighborhood Collective Efficacy Scale (NCES) is a
56 10-item scale, with five items each on informal social control and social cohesion.³⁸
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Socio-demographic information that may be confounders will be collected, including 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 as well as the comorbidities of parents and children will be recorded. 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 enrollment into the main cohort study. Data on such estimation of intelligence quotient (I.Q.) of the children will be retrieved and used as a confounder in the study.

Data processing and analysis

Descriptive statistics will be used to summarize the characteristics of parents and children at baseline and each follow-up time point. Intention to treat (ITT) analysis will be used to handle missing data due to loss to follow-up. Various statistical techniques will be employed based upon research questions. Latent growth modelling will be conducted to obtain the trajectory of parental stress and child health over times. The bidirectional relationship between parental stress and child health over times will be determined using cross lagged path model.³⁹ Linear mixed effect model, including subjects as random effects, will be performed to evaluate the association between parental variables and between children's variables. Mediation and moderation analysis will also be conducted to examine 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 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 allostatic load index
- Parental SF-12vs HRQOL scores

Mediators

- 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

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

Potential confounders include parent age and gender, child age and gender, household income; parental occupation, marital status, smoking and drinking among family members, parental and child's comorbidities and child cognitive skills.

Discussion

Exposure to the constant stresses 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 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 of the potential for improvement through interventions on parental stress and child health.

In addition to the evaluation of subjective child general health reported by the parent, measurement of telomere length in children will provide evidence on the biological health of the children at cellular level. We will also measure child BMI z-score which is a recognized indicator of child health to reflect the growth of the children. The results could 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, allostatic load in the parent will also be studied in this research. It represents the sum of physiological dysregulations in the body of an individual in response to chronic

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3 stressful situation prior to onset of medical illnesses, and is measured by a combination of
4 biomarkers of health such as blood pressure and plasma glucose level. The total “stress load”
5 is presented as a composite score, the allostatic load index, which predicts morbidity and
6 mortality. These results will provide the public with evidence of the biological impact of
7 stress perceived by the parents.
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11 Furthermore, this study will examine the mediators of the parent-child health
12 relationship. The findings would inform healthcare providers and policy makers on the
13 potential targets for intervention to improve both parent and child health (e.g. interventions
14 for intimate partner abuse and family disharmony, or enhanced care for depression and
15 anxiety). On the other hand, moderation analysis will focus on parenting style and
16 neighbourhood cohesion. These two factors were selected because of their potentials for
17 future interventions, e.g. parenting skill training and activities to promote neighbourhood
18 cohesion, which deem feasible and may benefit the whole community. For policy makers, the
19 results could be useful for informing the design of a holistic approach to address children’s
20 health issues and parental stress. Ultimately, targeted interventions at risk factors identified
21 by this study can be developed on the community level to improve the health of parents and
22 children of low-income families.
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31 **Ethics and dissemination**

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33 This study was approved by the institutional review board of the University of Hong Kong –
34 the Hospital Authority Hong Kong West Cluster, Reference number: UW 16-415. The study
35 findings will be disseminated through peer-reviewed publications and international
36 conferences.
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Acknowledgements

We are most grateful to Kerry Group Kuok Foundation (Hong Kong) Limited (KGKF) for their support. We thank the Neighborhood Advice-Action Council (NAAC) and Yat Tung (I/II) Estate Property Management in providing venue for our study. A special thanks to Versitech Ltd for granting us a complementary license to use the OPine Software for data collection in our study. The timely completion of the telephone surveys by the HKU Social Science Research Center is much appreciated. The hard work of our research staff in data collection and analysis must be acknowledged.

Contributions

RSMW, EYTY and CLKL conceived the study concept, developed the funding proposal and applied for funding. RSMW, EYTY, VYG, CKHW, CSCF coordinates the project. EYFW and CKHW developed the statistical analysis plan. KTST and WHSW provided input regarding the telomere length assay and interpretation aspects of the study. WYC, PI, AFYT provided expert opinion in mental health, child development and family relationship aspects of the protocol respectively. CLKL is the funding holder of the community family support programme for low-income families in Hong Kong funded by a philanthropic foundation in Hong Kong (Kerry Group Kuok Foundation (Hong Kong) Limited). EYTY is the principal investigator and the grant holder of the Health and Medical Research Fund of Hong Kong (HMRF/14151571). RSMW, EYTY and CLKL initiated the writing of the protocol paper. All authors revised and approved the final version of the manuscript.

Funding

This study was supported by Kerry Group Kuok Foundation (Hong Kong) Limited and the Health and Medical Research Fund of Hong Kong (HMRF/14151571).

Competing interests

The authors declare no conflict of interest.

Figure legend

Figure 1. Study conceptual model. Confounders include parent' age, gender, immigration status, occupation, marital status and history of smoking/drinking/drug use; child's age, gender and IQ; as well as monthly household income.

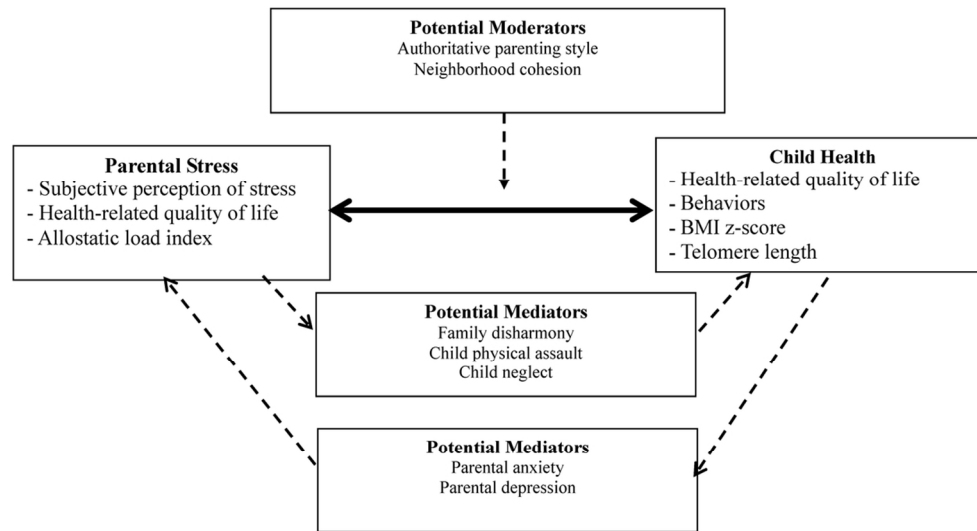


Figure 1. Study conceptual model. Confounders include parent' age, gender, immigration status, occupation, marital status and history of smoking/drinking/drug use; child's age, gender and IQ; as well as monthly household income.

108x58mm (300 x 300 DPI)

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of *cohort studies*

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study's design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-6
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	7
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	7-8
		(b) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	11-12
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	9-11
Bias	9	Describe any efforts to address potential sources of bias	11-13
Study size	10	Explain how the study size was arrived at	7
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	11-12
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	11-12
		(b) Describe any methods used to examine subgroups and interactions	11-12
		(c) Explain how missing data were addressed	NA
		(d) If applicable, explain how loss to follow-up was addressed	11-12
		(e) Describe any sensitivity analyses	NA
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	NA
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	NA
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	Report numbers of outcome events or summary measures over time	NA
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NA
		(b) Report category boundaries when continuous variables were categorized	NA
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	11-12
Discussion			
Key results	18	Summarise key results with reference to study objectives	12-13
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	12-13
Generalisability	21	Discuss the generalisability (external validity) of the study results	12-13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-018792.R1
Article Type:	Protocol
Date Submitted by the Author:	09-Nov-2017
Complete List of Authors:	Wong, Rosa Sze Man; The University of Hong Kong, Department of Family Medicine and Primary Care Yu, Esther Yee Tak; The University of Hong Kong, Department of Family Medicine and Primary Care Guo, Vivian Yawei; The University of Hong Kong, Department of Family Medicine and Primary Care Wan, Eric; The University of Hong Kong, Department of Family Medicine and Primary Care Chin, Weng Yee; The University of Hong Kong, Department of Family Medicine and Primary Care Wong, Carlos; The University of Hong Kong, Department of Family Medicine and Primary Care Fung, Colman; The University of Hong Kong, Department of Family Medicine and Primary Care Tung, Keith Tsz-Suen; The University of Hong Kong, Department of Paediatrics and Adolescent Medicine Wong, HSW; The University of Hong Kong, Department of Paediatrics and Adolescent Medicine Ip, Patrick; The University of Hong Kong, Department of Paediatrics and Adolescent Medicine Tiwari, Agnes Fung Yee ; Hong Kong Sanatorium & Hospital, School of Nursing Lam, Cindy; The University of Hong Kong, Department of Family Medicine and Primary Care
Primary Subject Heading:	Mental health
Secondary Subject Heading:	Epidemiology, General practice / Family practice, Health services research, Paediatrics
Keywords:	Parental stress, Child health, Health-related quality of life, Bidirectional relationship, Low-income families

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For peer review only

Title

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 focus on either adults or children but not both. Moreover, there is limited knowledge on the relationship between parental generalized 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 3 time points (baseline, 12-, and 24-months) on parental stress, health-related quality of life (HRQOL), and child health and behavior using both subjective measures and objective physiological parameters. This study will collect data using standardized measures on HRQOL and behaviors of children as well as 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 neighborhood conditions will also be assessed. Data will be analyzed using latent growth modeling 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 number: UW 16-415. The study findings will be disseminated through peer-reviewed publications and international conferences.

Trial registration number ClinicalTrials.Gov: NCT03185273

Strength 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 generalizability of our findings to other populations.

Introduction

Poverty is inextricably related to ill health; both can be trans-generational.¹ Dealing with economic hardship can cause substantial stress and negatively affect health. The Americans' Changing Lives Study which involved 3,617 participants found that higher levels of parental stress were related to poorer self-rated health in parents.² Moreover, economic 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 families⁴, 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 (GDP) of 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 behavioral 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 economic 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, economic 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 not only disrupts interpersonal relationships among family members but also has negative impact on parenting. Family conflicts and aggressive and neglectful parenting practices are particularly harmful to

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3 children's behavioral development, as conflicts and aggressive parenting behaviors can be
4 observed and learned by their children. Children growing up in such aggressive families may
5 believe that family aggression is acceptable and thus become more likely to behave in
6 aggressive or harmful ways toward others.^{12 13} On the other hand, neglectful parents tend to
7 show minimal physical affection toward their children, know little about child development
8 and have incompetent caretaking skills¹⁴ which can put their children at a higher risk for
9 obesity and other diseases. These childhood problems might in turn intensify feeling of
10 distress in parents. The pathway linking children's problems to parental stress has been
11 underexplored and thus warrants further investigations. Furthermore, despite growing
12 empirical support for the Family Stress Model, such model is not static and more empirical
13 evaluations are needed to identify risk and protective factors for changing the family stress
14 process.¹⁵

24 *Parental stress and its biological effects*

25 "Parental stress" refers to stress, defined as negative emotional experiences
26 accompanied by predictable biochemical, physiological, cognitive, and behavioral changes
27 directed either towards altering the stressful event or accommodating to its effects, which
28 parents experience in general term.¹⁶ Parental stress does not only result from child-rearing,
29 but also from their social and environmental circumstances, responsibilities, and everyday
30 life such as insufficient social support, economic challenges and heavy parenting
31 responsibilities.¹⁷ Under chronic stressful conditions, excessive strain on the body can cause
32 cumulative damages to physiological systems (e.g. cardiovascular, metabolic, anthropometric,
33 neuroendocrine and immune systems) which is often referred as allostatic load (AL).¹⁸ Adults
34 with high AL had been found to be more vulnerable to a number of physical, mental and
35 behavioral disorders such as cardiovascular disease, depression and aggression.¹⁹

45 *Biological effects of stress on child health*

46 According to the 2007 United Nations International Children's Emergency Fund
47 (UNICEF) report, child health is a multidimensional construct that involves material
48 well-being, health and safety, education, family and peer relationships, subjective well-being,
49 behaviors and lifestyles.²⁰ Previous studies showed that adverse childhood experiences such
50 as chronic economic stress can cause impairments in these health dimensions by disrupting
51 various physiological systems in children.²¹ Poor child health in turn limits a child's potential
52 to interact successfully with the environments.²² However, traditional AL markers cannot be

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3 easily measured in children because of difficulty in blood sampling. To overcome this
4 limitation, child health researchers have explored other noninvasive ways to collect biological
5 samples from children for examination of objective physiological markers. An increasingly
6 used method is to measure telomere length in children's buccal cells. Telomeres are essential
7 components that protect the ends of chromosomes and shorten each time a cell divides. As a
8 biomarker of cellular and biologic aging, telomere shortening is associated with a number of
9 adverse health outcomes in adulthood. Previous studies on telomere length in children
10 focused on severe environmental adversities in early childhood such as living in institutions²³
11 and prenatal tobacco exposure,²⁴ and demonstrated that adverse living environment led to
12 telomere shortening in exposed children. Children with family adversity had been found to
13 have shorter telomeres and greater cortisol reactivity to stress,^{25 26} which were associated with
14 poorer health outcomes later in life.²⁷ At present, telomere length is regarded as a marker of
15 stress exposure in children.²⁷ However, evidence on the long term impact of telomere
16 shortening since early childhood on health in adulthood is not yet available and warrants
17 further research.

28 *Relationship between parental stress and child health*

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30 Research evidence shows that maternal stressful experiences during pregnancy and in
31 early postnatal period can lead to biological changes including neuroendocrine, epigenetic,
32 and neuroanatomical changes in children,²⁸ thereby increasing their risk for health and
33 behavioral problems later in life. On the other hand, more health and behavioral problems in
34 children may add to greater parental stress due to more caregiving responsibilities. This can
35 further damage the parent-child relationship. A bidirectional relationship between specific
36 form of parental stress such as parenting stress and child behaviors has been documented in
37 some studies.^{12 13} But little is known about the relationship between general form of parental
38 stress and child health. In addition, previous research has been largely unidirectional,
39 assuming that parental stress damages child health. The opposite direction that children
40 influence parental stress is possible but scarcely studied.

41 *Potential mediators and moderators*

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43 Despite the health risks of economic hardship, certain individual and environmental
44 factors might mitigate the negative consequences of growing up in a low-income
45 household.²⁷ It has been posited that economic disadvantage is a risk factor for exposure to
46 trauma and violence.¹ As illustrated in the Family Stress Model, low income can induce

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3 pressure and stress which is associated with abusive parenting.²⁹ Different meta-analyses on
4 childhood abusive experiences, particularly physical abuse, have found significantly shorter
5 telomeres and more physical and mental health problems in abuse victims.³⁰⁻³² The Family
6 Stress Model also emphasizes the importance of family relationship in children's lives. When
7 economic pressure is high, economic hardship can exacerbate parental stress and increases
8 conflicts and chaos in the family environment.³³ Children growing up in such hostile
9 environment may have more behavioral problems^{34 35} and a higher risk of obesity.³⁶
10 Furthermore, when children suffer health and behavioral problems, stressful parenting
11 experiences can inflict other negative emotional symptoms such as anxiety and depression
12 which may further exacerbate distress in parents³⁷.

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21 Although living on a low income can be stressful, many stressed parents are still able to
22 provide adequate care to their children.³⁸ There is evidence that appropriate parenting
23 behaviors such as use of reason rather than corporal punishment to discipline children can
24 moderate the relationship between parenting stress and physical child abuse potential.³⁹
25 Many experts believe that authoritative parenting style is the most suitable parenting style in
26 bringing up a child. Authoritative parenting practices are characterized by high
27 responsiveness and reasonable demands such as setting concrete, age-appropriate
28 expectations for children. Authoritative parenting style has been found to cause fewer
29 behavioral and health problems in children^{40 41}. In addition, neighborhood characteristics
30 might also function to protect children against the negative consequences of parental stress.
31 In cohesive neighborhoods where residents have a sense of trust and belongingness to each
32 other, parents can seek support from their neighbors when they need help with childcare.
33 Research show that more neighborhood cohesion predicts better development and behavioral
34 outcomes in children.⁴² Despite the established benefits, neither authoritative parenting style
35 nor neighborhood cohesion has been studied as a moderator of the relationship between
36 parental stress and child health.

47 48 *The present study*

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50 This study aims to explore whether there is a bi-directional relationship between
51 parental stress and child health, and to examine the mediators and moderators of the
52 relationship between parental stress and child health. The study conceptual model is shown in
53 Figure 1. We hypothesize that there is a bi-directional relationship between parental stress
54 and child health. We further hypothesize that family disharmony and child maltreatment are
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mediators of the association between parental stress and child health, whereas authoritative parenting style and neighborhood cohesion moderate 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 behavioral problems compared to 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 allostatic load on the body.
- To examine the associations between children's HRQOL, behaviors, 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 upon 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) Limited).^{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 health-related quality of life (HRQOL), family harmony, parenting style, neighborhood 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 2016-17 with follow-up assessments at 12 and 24 months.

Ethics

The ethics of this study has been approved by the institutional review board of the

University of Hong Kong – the Hospital Authority Hong Kong West Cluster, Reference number: UW 16-415.

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 (i) $10 \times (\text{number of factors})$, (ii) $50 + \text{number of factors}$ and (iii) $50 + 8 \times (\text{number of factors})$.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 (iii) is better than rule (i) and (ii) at 80% power and 5% level of significance if an 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 (i.e. the child agreeing to take part in cognitive assessment on recruitment) and his/her primary custodial parent (i.e. 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; and
- At least one parent and one child aged 6 to 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; and
- Neither parent is the primary caregiver of the child.

Recruitment

We will approach eligible participants in the main cohort study by telephone or during

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3 face-to-face sessions. A research assistant will inform eligible participants about the study
4 and will obtain information and signed consent from those who express interest in study
5 participation. After providing consent, the parent of each participating parent-child pair will
6 spend 45-60 minutes to complete a set of structured and standardized questionnaires on
7 parental mental health and HRQOL, parenting style, their children's well-being and behaviors,
8 and family and neighborhood environment. The questionnaires had been pilot-tested in
9 several low-income parents and minor editing was done to ensure the questionnaires are
10 comprehensible to the respondent. The questionnaires will be administered in two separate
11 batches (the first includes parent and child measures and the second includes family and
12 neighborhood measures). They will be administered by trained interviewers by face-to-face
13 interview or telephone. If the parent cannot answer all the questionnaire items within one
14 telephone interview or face-to-face session, the remaining unanswered items can be
15 completed in next telephone interview session or self-completed at home and returned to the
16 research office using our prepaid envelope. Physical examination on both the parent and child
17 will include blood pressure, heart rate, weight, height, and waist-to-hip ratio. Each child will
18 have a buccal cell swab taken for measurement of their telomere length and each adult will
19 have a 15ml of venous blood sample taken for fasting glucose test, glycosylated haemoglobin
20 test, and full lipid profile test.
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33 **Assessment procedure**

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35 This study will have three assessment waves: T1 Baseline, T2 follow up (12 months),
36 and T3 follow up (24 months). Table 1 shows the measurement and time points at which data
37 will be collected.
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40 Physical health data and biological samples will be collected by research nurses and
41 research assistants during health assessment session held in community centers.
42 Questionnaire data will be collected by trained interviewers during a telephone survey. To
43 minimize attrition, a package of questionnaires and a sheet of instructions and equipment (i.e.
44 brushes) for swab-taking at home may also be sent to parents upon request. Parent-child pairs
45 will be reimbursed HK\$50 (US\$6.4) for the baseline and HK\$100 (US\$12.8) for the
46 12-month and 24-month assessment.
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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
Social-economic 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
Co-morbidities	x	x	x	x	x	x
Family and Neighborhood						
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	

Abbreviations: 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; PHQ: Patient Health Questionnaire; PSDQ: Parenting Style and Dimension Questionnaire; NCES: Neighborhood Collective Efficacy Scale; 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)

Maintenance Strategies

This study will recruit participants from 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 socio-economical 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 maximize 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) is a parent proxy measure of children's physical and psychological wellbeing, 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 0.94⁴⁷. Its Chinese version has been used in local Chinese children.^{43 48}

Strength and Difficulties Questionnaire (SDQ) is a 25-item parent-completed questionnaire measuring children's behavioral issues. The SDQ, with 5 subscales, has been translated into

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3 traditional Chinese and tested with satisfactory reliability (Cronbach's alpha: 0.66 to 0.81)
4 and validity in local children.^{43 49}
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8 Telomere length: DNA will be extracted from buccal epithelial cells. Telomere length will be
9 measured by the method adapted from that originally published by Cawthon.⁵⁰ For each
10 sample, the telomere length will be represented by the relative ratio of the telomere repeat
11 copy number (T) to the single copy gene 36BA copy number (S). The T/S ratio will be
12 determined by quantitative polymerase chain reaction (qPCR) using a 7900HT Thermocycler
13 (Applied Biosystems). The quality of extracted DNA, as indicated by the value
14 of A260/A280 ratio, will be determined by using the NanoDrop 2000c spectrophotometer
15 (Thermo Scientific).
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23 Body Mass Index (BMI) z-score: As BMI (calculated as weight/height²) changes rapidly in
24 childhood, and growth patterns differ between boys and girls, BMI will be converted to
25 z-score based on the international child growth reference.⁵¹ This method allows for direct
26 comparison of BMI and its changes across different ages and genders.
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30 Parental health

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32 Mental health: Depression Anxiety Stress Scale (DASS) has 3 subscales, each with 7 items
33 rating the severity/frequency of symptoms of stress, anxiety and depression respectively. The
34 total score of each dimension can be categorized as "normal", "mild", "moderate", "severe",
35 and "extremely severe", according to the DASS manual⁵². DASS also has well-established
36 psychometric properties⁵² and been validated in Chinese population (Cronbach's alpha: 0.80
37 to 0.82).⁵³ In addition, Patient Health Questionnaire – 9 (PHQ-9) will be used to screen for
38 depression in parents. The Chinese version of PHQ-9 has been validated and used in previous
39 local studies.⁴³
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47 Quality of life: The SF-12 Health Survey-Version 2 (SF-12v2) is a 12-item quality of life
48 assessment instrument, producing 8 subscales and 2 composite summary scores. The Chinese
49 version of SF-12v2 has been validated and normed in local Chinese population with
50 Cronbach's alpha coefficient ranging from 0.60 to 0.89.^{43 54 55}
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55 Allostatic load index: A review of literature has identified a set of physiological parameters
56 that can reflect AL and yet be conveniently measured, including blood pressure, heart rate,
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3 BMI, waist-to-hip ratio, lipid profile, fasting glucose and glycosylated haemoglobin.¹⁸ This
4 set of physiological parameters will be measured and included in the calculation of AL index
5 in this study. An index score of AL is calculated by summing the number of parameters that
6 fall into the “highest” risk quartile defined by local clinical practice guidelines.
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11 Screening for depression: Patient Health Questionnaire – 9 (PHQ – 9) is used to screen for
12 depression in the parent. The Chinese version of PHQ-9 has been validated and used in
13 previous local studies (Cronbach’s alpha: 0.82).⁴³
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16 17 Family and neighborhood environment

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19 Family environment: The Chinese version of Family Harmony Scale – 5 (FHS-5) will be
20 used to measure family harmony (Cronbach’s alpha: 0.92).⁵⁶ Parental risk of physically
21 abusing and neglecting children as well as their parenting style will also be assessed with the
22 Child Physical Assault and Neglect subscale of the Parent Child Conflict Tactics Scale
23 (CTSPC) (Cronbach’s alpha: 0.77 to 0.88)⁵⁷ and the Authoritative Parenting Style subscale
24 of the Parenting Style and Dimension Questionnaire (PSDQ) (Cronbach’s alpha: 0.71 to
25 0.97),^{58 59} respectively.
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32 Neighborhood: The Chinese version of Neighborhood Collective Efficacy Scale (NCES) is a
33 10-item scale, with five items each on informal social control and social cohesion
34 (Cronbach’s alpha: 0.63).⁶⁰
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39 The following socio-demographic characteristics will be considered to be potential
40 confounding factors on the basis of their potential associations with parental stress and child
41 health: household income, children’s age and gender, and parental age and gender, education
42 level, occupation, marital status, and immigration status. Parental history of smoking,
43 drinking and illicit drug use, occupation and marital status, comorbidities of parents and
44 children, and household income will be recorded at baseline and follow-ups. The cognitive
45 abilities of the child from each household were assessed by a clinical psychologist using the
46 Wechsler Intelligence Scale for Children Fourth Edition – Hong Kong (Short Form)
47 (WISC-IV-HK-SF) at the time of enrollment into the main cohort study. Data on such
48 estimation of intelligence quotient (I.Q.) of the children will be retrieved and used as a
49 confounder in the study.
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Data processing and analysis

Descriptive statistics will be used to summarize 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 manual⁵². The psychometric properties such as construct validity, convergent and divergent validity, and Cronbach's alphas for the scales used will also be reported. 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 (MAR). Latent growth modelling will be conducted to obtain how the parental stress and child health changes over times. The bidirectional relationship between parental stress and child health over times will be determined using cross-lagged path model (Figure 2).⁶¹ Linear mixed effect model, including subjects as random effects, will be performed to evaluate the association between parental variables and between children's variables. 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 allostatic load 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

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3 the PSDQ

- 4 • Neighbourhood cohesion measured by NCES
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8 Potential confounders include sociodemographic information (parental age and gender,
9 child age and gender, household income, parental occupation, and marital status), parental
10 history of smoking, drinking and illicit drug use, parental and child history of comorbidities
11 and child cognitive skills. All statistical analyses will be performed using IBM SPSS
12 Statistics and Mplus. All significance tests will be two-tailed and findings with a p-value less
13 than 0.05 will be considered statistically significant.
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18 **Discussion**

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20 Chronic exposure to stressors and dangers of poverty can have a detrimental impact on
21 the health of parents and their children. It is important to mitigate the effect of poverty
22 through protective mechanisms, the development of which should be guided by empirical
23 evidence. Although it is known that poverty and poor health are linked with each other, the
24 present research, with an aim to elucidate the relationship between parental stress and child
25 health in low-income families, will give further insights into the possible vicious cycle of ill
26 health between parents and children, an aspect that is often overlooked. For example, the
27 question of whether changes in parental stress correlate with changes in child health over
28 time and its magnitude will be investigated. The result will inform various stakeholders about
29 the potential of improvement through interventions on parental stress and child health.
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39 In addition to parent-proxy reports of children's general health, measurement of
40 telomere length in children will provide more convincing evidence on the biological health of
41 the children at cellular level. We will also measure child BMI z-score which is a recognized
42 indicator of child health to reflect the growth of the children. The results will help to establish
43 the robustness of assessing child general health using parent-proxy report and/or telomere
44 length as a measure of child health for either clinical use or future research purposes.
45 Moreover, parental allostatic load index will also be studied in this research. The index
46 represents the sum of physiological dysregulations in the body of an individual in response to
47 chronic stressful situation prior to onset of medical illnesses, and is measured by a
48 combination of biomarkers of health such as blood pressure and plasma glucose level. The
49 total "stress load" is presented as a composite score, the allostatic load index, which predicts
50 morbidity and mortality. These results will provide the public with evidence of the biological
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3 impact of perceived stress on parents.
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6 Furthermore, this study will examine the mediators of the parent-child health
7 relationship. The findings would inform healthcare providers and policy makers on the
8 potential targets for intervention to improve both parental and child health (e.g. interventions
9 for intimate partner abuse and family disharmony, or enhanced care for depression and
10 anxiety). On the other hand, moderation analysis will focus on authoritative parenting style
11 and neighbourhood cohesion. These two factors were selected because of their potentials for
12 improvement through interventions, e.g. parenting skill training and community fun day,
13 which deem feasible and may benefit the whole community. For policy makers, the results
14 could be useful for informing the design of a holistic approach to address children's health
15 issues and parental stress. Ultimately, targeted interventions at risk factors identified by this
16 study can be developed at the community level to improve the health of parents and children
17 of low-income families.
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27 This study has several strengths and limitations. Some children in this study are quite
28 young and may not be able to give reliable information on their own health status. Children's
29 HRQOL and behaviors will therefore be proxy-reported by their parents. Despite this
30 limitation, this study not only assesses participants' perceived health status but also uses
31 objective measures such as telomere length measurement and allostatic load index calculation
32 to give a holistic view of the health conditions of study participants. The inclusion of both
33 objective and participant-reported outcomes can increase the reliability of the findings by
34 reducing response bias. In addition, this study provides longitudinal data which make it
35 possible to examine cause-effect relationships between variables. The results will be useful to
36 advance our understanding of the linkage between parental and child health. However, this
37 study focuses on a subgroup of low-income families in Hong Kong which is not a
38 population-representative sample and hence the findings may not be generalizable to other
39 populations. Moreover, in order to reduce the respondent burden (and response rate) in the
40 completion of the large number of questionnaires, the outcomes will be measured only at
41 three time points. Further follow-up assessment should be conducted if resources are
42 available.
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54 **Ethics and dissemination**

55 This study was approved by the institutional review board of the University of Hong Kong –
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3 the Hospital Authority Hong Kong West Cluster, Reference number: UW 16-415. The study
4 findings will be disseminated through peer-reviewed publications and international
5 conferences.
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18 **Acknowledgements**

19
20 We are most grateful to Kerry Group Kuok Foundation (Hong Kong) Limited (KGKF) for
21 their support. We thank the Neighborhood Advice-Action Council (NAAC) and Yat Tung (I/II)
22 Estate Property Management in providing venue for our study. A special thanks to Versitech
23 Ltd for granting us a complementary license to use the OPine Software for data collection in
24 our study. The timely completion of the telephone surveys by the HKU Social Science
25 Research Center is much appreciated. The hard work of our research staff in data collection
26 and analysis must be acknowledged.
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37 **Contributions**

38 RSMW, EYTY and CLKL conceived the study concept, developed the funding proposal and
39 applied for funding. RSMW, EYTY, VYG, CKHW, CSCF coordinates the project. EYFW
40 and CKHW developed the statistical analysis plan, and contributed to the interpretation of
41 data. KTST and WHSW provided input regarding the telomere length assay and
42 interpretation aspects of the study. WYC, PI, AFYT provided expert opinion in mental health,
43 child development and family relationship aspects of the protocol respectively. CLKL is the
44 funding holder of the community family support programme for low-income families in
45 Hong Kong funded by a philanthropic foundation in Hong Kong (Kerry Group Kuok
46 Foundation (Hong Kong) Limited). EYTY is the principal investigator and the grant holder of
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3 the Health and Medical Research Fund of Hong Kong (HMRF/14151571). RSMW, EYTY
4 and CLKL initiated the writing of the protocol paper. All authors revised and approved the
5
6 final version of the manuscript.
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10 11 **Funding**

12
13 This study was supported by Kerry Group Kuok Foundation (Hong Kong) Limited and the
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15 Health and Medical Research Fund of Hong Kong (HMRF/14151571).
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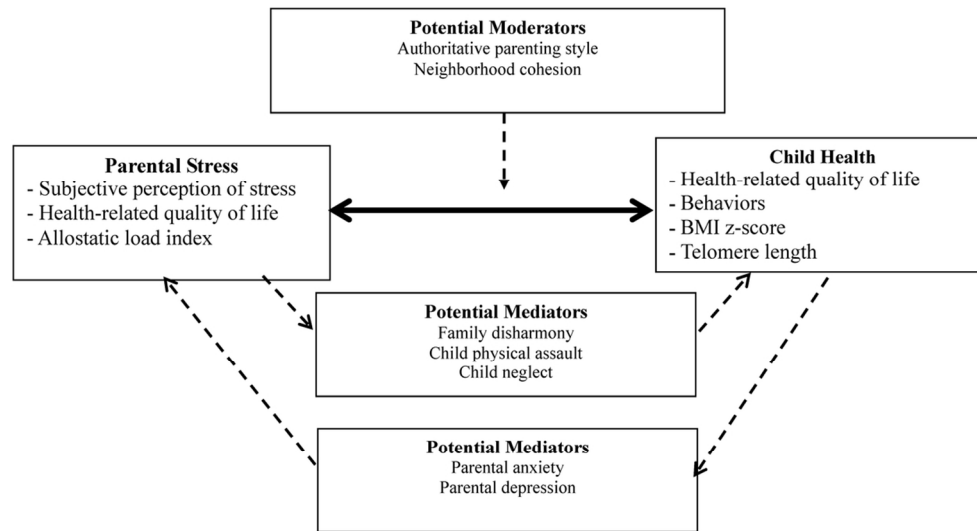
20 **Competing interests**

21
22 The authors declare no conflict of interest.
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29 **Figure legend**

30
31 **Figure 1.** Study conceptual model. Potential confounders include baseline sociodemographic
32
33 information (parental age and gender, child age and gender, household income, parental
34
35 occupation, and marital status), parental history of smoking, drinking and illicit drug use,
36
37 parental and child history of comorbidities and child cognitive skills.
38

39 **Figure 2.** Hypothesized cross-lagged path model predicting child health and parental stress
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41 from baseline to 24-months follow-up.
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25 Figure 1. Study conceptual model. Potential confounders include baseline sociodemographic information
 26 (parental age and gender, child age and gender, household income, parental occupation, and marital
 27 status), parental history of smoking, drinking and illicit drug use, parental and child history of comorbidities
 28 and child cognitive skills.

29 108x58mm (300 x 300 DPI)

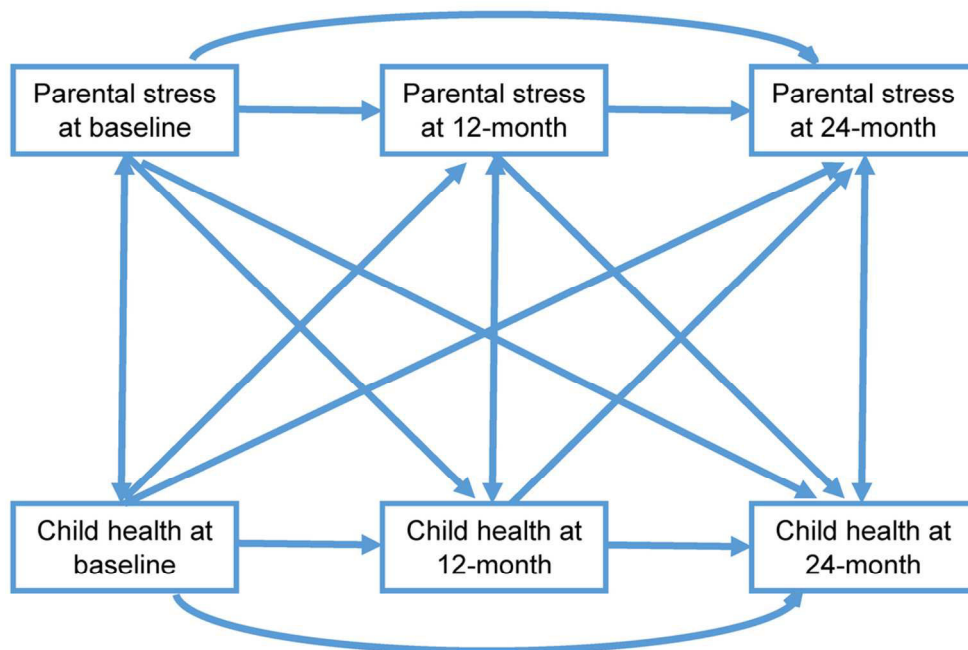


Figure 2. Hypothesized cross-lagged path model predicting child health and parental stress from baseline to 24-months follow-up.

102x68mm (300 x 300 DPI)

Review only

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cohort studies

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-8
Objectives	3	State specific objectives, including any prespecified hypotheses	8
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	9
		(b) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	14
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	11-13
Bias	9	Describe any efforts to address potential sources of bias	10-14
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	13-14
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	13-14
		(b) Describe any methods used to examine subgroups and interactions	13-14
		(c) Explain how missing data were addressed	NA
		(d) If applicable, explain how loss to follow-up was addressed	13-14
		(e) Describe any sensitivity analyses	NA
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	NA
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	NA
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	Report numbers of outcome events or summary measures over time	NA
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NA
		(b) Report category boundaries when continuous variables were categorized	NA
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13-14
Discussion			
Key results	18	Summarise key results with reference to study objectives	14-16
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	14-16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2017-018792.R2
Article Type:	Protocol
Date Submitted by the Author:	11-Jan-2018
Complete List of Authors:	Wong, Rosa Sze Man; The University of Hong Kong, Department of Family Medicine and Primary Care Yu, Esther Yee Tak; The University of Hong Kong, Department of Family Medicine and Primary Care Guo, Vivian Yawei; The University of Hong Kong, Department of Family Medicine and Primary Care Wan, Eric; The University of Hong Kong, Department of Family Medicine and Primary Care Chin, Weng Yee; The University of Hong Kong, Department of Family Medicine and Primary Care Wong, Carlos; The University of Hong Kong, Department of Family Medicine and Primary Care Fung, Colman; The University of Hong Kong, Department of Family Medicine and Primary Care Tung, Keith Tsz-Suen; The University of Hong Kong, Department of Paediatrics and Adolescent Medicine Wong, HSW; The University of Hong Kong, Department of Paediatrics and Adolescent Medicine Ip, Patrick; The University of Hong Kong, Department of Paediatrics and Adolescent Medicine Tiwari, Agnes Fung Yee ; Hong Kong Sanatorium & Hospital, School of Nursing Lam, Cindy; The University of Hong Kong, Department of Family Medicine and Primary Care
Primary Subject Heading:	Mental health
Secondary Subject Heading:	Epidemiology, General practice / Family practice, Health services research, Paediatrics
Keywords:	Parental stress, Child health, Health-related quality of life, Bidirectional relationship, Low-income families

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For peer review only

Title

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 generalized 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 3 time points (baseline, 12-, and 24-month) on parental stress, health-related quality of life (HRQOL), and child health and behavior using both subjective measures and objective physiological parameters. This study will collect data using standardized measures on HRQOL and behaviors of children as well as 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 neighborhood conditions will also be assessed. Data will be analyzed using latent growth modeling 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 number: UW 16-415. The study findings will be disseminated through peer-reviewed publications and international conferences.

Trial registration number ClinicalTrials.Gov: NCT03185273

Strength 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-month).
- 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 generalizability of our findings to other populations.

Introduction

Poverty is inextricably related to ill health; both can be trans-generational.¹ Dealing with financial hardship can cause substantial stress and negatively affect health. The Americans' Changing Lives Study which involved 3,617 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 families⁴, 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 (GDP) of 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 behavioral 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 not only disrupts interpersonal relationships among family members but also has negative impact on parenting. Family conflicts and aggressive and neglectful parenting practices are particularly harmful to

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3 children's behavioral development, as conflicts and aggressive parenting behaviors can be
4 observed and learned by their children. Children growing up in such aggressive families may
5 believe that family aggression is acceptable and thus become more likely to behave in
6 aggressive or harmful ways toward others.^{12 13} On the other hand, neglectful parents tend to
7 show minimal physical affection toward their children, know little about child development
8 and have incompetent caretaking skills¹⁴ which can put their children at a higher risk for
9 obesity and other diseases. These childhood problems might in turn intensify feeling of
10 distress in parents. The pathway linking children's problems to parental stress has been
11 underexplored and thus warrants further investigations. Furthermore, despite growing
12 empirical support for the Family Stress Model, such model is not static and more empirical
13 evaluations are needed to identify risk and protective factors for changing the family stress
14 process.¹⁵

24 *Parental stress and its biological effects*

25 "Parental stress" refers to stress, defined as negative emotional experiences
26 accompanied by predictable biochemical, physiological, cognitive, and behavioral changes
27 directed either towards altering the stressful event or accommodating to its effects, which
28 parents experience in general term.¹⁶ Parental stress does not only result from child-rearing,
29 but also from their social and environmental circumstances, responsibilities, and everyday
30 life such as insufficient social support, financial challenges and heavy parenting
31 responsibilities.¹⁷ Under chronic stressful conditions, excessive strain on the body can cause
32 cumulative damages to physiological systems (e.g. cardiovascular, metabolic, anthropometric,
33 neuroendocrine and immune systems) which is often referred as allostatic load (AL).¹⁸ Adults
34 with high AL had been found to be more vulnerable to a number of physical, mental and
35 behavioral disorders such as cardiovascular disease, depression and aggression.¹⁹

45 *Biological effects of stress on child health*

46 According to the 2007 United Nations International Children's Emergency Fund
47 (UNICEF) report, child health is a multidimensional construct that involves material
48 well-being, health and safety, education, family and peer relationships, subjective well-being,
49 behaviors and lifestyles.²⁰ Previous studies showed that adverse childhood experiences such
50 as chronic family financial stress can cause impairments in these health dimensions by
51 disrupting various physiological systems in children.²¹ Poor child health in turn limits a
52 child's potential to interact successfully with the environments.²² However, traditional AL

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3 markers cannot be easily measured in children because of the difficulty in blood sampling. To
4 overcome this limitation, child health researchers have explored other noninvasive ways to
5 collect biological samples from children for examination of objective physiological markers.
6 An increasingly used method is to measure telomere length in children's buccal cells.
7 Telomeres are essential components that protect the ends of chromosomes and shorten each
8 time a cell divides. As a biomarker of cellular and biologic aging, telomere shortening is
9 associated with a number of adverse health outcomes in adulthood. Previous studies on
10 telomere length in children focused on severe environmental adversities in early childhood
11 such as living in institutions²³ and prenatal tobacco exposure,²⁴ and demonstrated that adverse
12 living environment led to telomere shortening in exposed children. Children with family
13 adversity had been found to have shorter telomeres and greater cortisol reactivity to stress,²⁵
14 ²⁶ which were associated with poorer health outcomes later in life.²⁷ At present, telomere
15 length is regarded as a marker of stress exposure in children.²⁷ However, evidence on the long
16 term impact of telomere shortening since early childhood on health in adulthood is not yet
17 available and warrants further research.
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28 *Relationship between parental stress and child health*

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30 Research evidence shows that maternal stressful experiences during pregnancy and in
31 early postnatal period can lead to biological changes including neuroendocrine, epigenetic,
32 and neuroanatomical changes in children,²⁸ thereby increasing their risk for health and
33 behavioral problems later in life. On the other hand, more health and behavioral problems in
34 children may add to greater parental stress due to more caregiving responsibilities. This can
35 further damage the parent-child relationship. A bidirectional relationship between specific
36 form of parental stress such as parenting stress and child behaviors has been documented in
37 some studies.^{12 13} But little is known about the relationship between general form of parental
38 stress and child health. In addition, previous research has been largely unidirectional,
39 assuming that parental stress damages child health. The opposite direction that children
40 influence parental stress is possible but scarcely studied.
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50 *Potential mediators and moderators*

51 Despite the health risks of family financial hardship, certain individual and
52 environmental factors might mitigate the negative consequences of growing up in a
53 low-income household.²⁷ It has been posited that financial disadvantage is a risk factor for
54 exposure to trauma and violence.¹ As illustrated in the Family Stress Model, low income can
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3 induce pressure and stress which is associated with abusive parenting.²⁹ Different
4 meta-analyses on childhood abusive experiences, particularly physical abuse, have found
5 significantly shorter telomeres and more physical and mental health problems in abuse
6 victims.³⁰⁻³² The Family Stress Model also emphasizes the importance of family relationship
7 in children's lives. When financial pressure is high, financial hardship can exacerbate parental
8 stress and increases conflicts and chaos in the family environment.³³ Children growing up in
9 such hostile environment may have more behavioral problems^{34 35} and a higher risk of
10 obesity.³⁶ Furthermore, when children suffer health and behavioral problems, stressful
11 parenting experiences can inflict other negative emotional symptoms such as anxiety and
12 depression which may further exacerbate distress in parents³⁷.

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21 Although living on a low income can be stressful, many stressed parents are still able to
22 provide adequate care to their children.³⁸ There is evidence that appropriate parenting
23 behaviors such as use of reason rather than corporal punishment to discipline children can
24 moderate the relationship between parenting stress and physical child abuse potential.³⁹
25 Many experts believe that authoritative parenting style is the most suitable parenting style in
26 bringing up a child. Authoritative parenting practices are characterized by high
27 responsiveness and reasonable demands such as setting concrete, age-appropriate
28 expectations for children. Authoritative parenting style has been found to cause fewer
29 behavioral and health problems in children^{40 41}. In addition, neighborhood characteristics
30 might also function to protect children against the negative consequences of parental stress.
31 In cohesive neighborhoods where residents have a sense of trust and belongingness to each
32 other, parents can seek support from their neighbors when they need help with childcare.
33 Research show that more neighborhood cohesion predicts better development and behavioral
34 outcomes in children.⁴² Despite the established benefits, neither authoritative parenting style
35 nor neighborhood cohesion has been studied as a moderator of the relationship between
36 parental stress and child health.

47 48 *The present study*

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50 This study aims to explore whether there is a bi-directional relationship between
51 parental stress and child health, and to examine the mediators and moderators of the
52 relationship between parental stress and child health. The study conceptual model is shown in
53 Figure 1. We hypothesize that there is a bi-directional relationship between parental stress
54 and child health. We further hypothesize that family disharmony and child maltreatment are
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mediators of the association between parental stress and child health, whereas authoritative parenting style and neighborhood 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 behavioral problems compared to 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 allostatic load on the body.
- To examine the associations between children's HRQOL, behaviors, 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 upon 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) Limited).^{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, neighborhood 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 2016-17 with follow-up assessments at 12 and 24 months.

Ethics

The ethics of this study has been approved by the institutional review board of the

University of Hong Kong – the Hospital Authority Hong Kong West Cluster, Reference number: UW 16-415.

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 (i) $10 \times (\text{number of factors})$, (ii) $50 + \text{number of factors}$ and (iii) $50 + 8 \times (\text{number of factors})$.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 (iii) is better than rule (i) and (ii) at 80% power and 5% level of significance if an 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 (i.e. the child agreeing to take part in cognitive assessment on recruitment) and his/her primary custodial parent (i.e. 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; and
- At least one parent and one child aged 6 to 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; and
- Neither parent is the primary caregiver of the child.

Recruitment

We will approach eligible participants in the main cohort study by telephone or during

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3 face-to-face sessions. A research assistant will inform eligible participants about the study
4 and will obtain information and signed consent from those who express interest in study
5 participation. After providing consent, the parent of each participating parent-child pair will
6 spend 45-60 minutes to complete a set of structured and standardized questionnaires on
7 parental mental health and HRQOL, parenting style, their children's well-being and behaviors,
8 and family and neighborhood environment. The questionnaires had been pilot-tested in
9 several low-income parents and minor editing was done to ensure the questionnaires are
10 comprehensible to the respondents. The questionnaires will be administered in two separate
11 batches (the first includes parent and child measures and the second includes family and
12 neighborhood measures). They will be administered by trained interviewers by face-to-face
13 interview or telephone. If the parent cannot answer all the questionnaire items within one
14 telephone interview or face-to-face session, the remaining unanswered items can be
15 completed in next telephone interview session or self-completed at home and returned to the
16 research office using our prepaid envelope. Physical examination on both the parent and child
17 will include blood pressure, heart rate, weight, height, and waist-to-hip ratio. Each child will
18 have a buccal cell swab taken for measurement of their telomere length, and each adult will
19 have a 15ml of venous blood sample taken for fasting glucose test, glycosylated haemoglobin
20 test, and full lipid profile test.
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33 **Assessment procedure**

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35 This study will have three assessment waves: T1 Baseline, T2 follow up (12 months),
36 and T3 follow up (24 months). Table 1 shows the measurement and time points at which data
37 will be collected.
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40 Physical health data and biological samples will be collected by research nurses and
41 research assistants during health assessment session held in community centers.
42 Questionnaire data will be collected by trained interviewers during a telephone survey. To
43 minimize attrition, a package of questionnaires and a sheet of instructions and equipment (i.e.
44 brushes) for swab-taking at home may also be sent to parents upon request. Parent-child pairs
45 will be reimbursed HK\$50 (US\$6.4) for the baseline and HK\$100 (US\$12.8) for the
46 12-month and 24-month assessment.
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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
Social-economic 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
Co-morbidities	x	x	x	x	x	x
Family and Neighborhood						
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	

Abbreviations: 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; PHQ: Patient Health Questionnaire; PSDQ: Parenting Style and Dimension Questionnaire; NCES: Neighborhood Collective Efficacy Scale; 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)

Maintenance Strategies

This study will recruit participants from 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 socio-economical 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 maximize 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) is a parent proxy measure of children's physical and psychological wellbeing, with 50 items grouped into 12 multi-item

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3 subscales. The tool has good psychometric properties with Cronbach's alpha coefficient
4 ranging from 0.66 to 0.94⁴⁷. Its Chinese version has been used in local Chinese children.^{43 48}
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8 Strength and Difficulties Questionnaire (SDQ) is a 25-item parent-completed questionnaire
9 measuring children's behavioral issues. The SDQ, with 5 subscales, has been translated into
10 traditional Chinese and tested with satisfactory reliability (Cronbach's alpha: 0.66 to 0.81)
11 and validity in local children.^{43 49}
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16 Telomere length: DNA will be extracted from buccal epithelial cells. Telomere length will be
17 measured by the method adapted from that originally published by Cawthon.⁵⁰ For each
18 sample, the telomere length will be represented by the relative ratio of the telomere repeat
19 copy number (T) to the single copy gene 36BA copy number (S). The T/S ratio will be
20 determined by quantitative polymerase chain reaction (qPCR) using a 7900HT Thermocycler
21 (Applied Biosystems). The quality of extracted DNA, as indicated by the value
22 of A260/A280 ratio, will be determined by using the NanoDrop 2000c spectrophotometer
23 (Thermo Scientific).
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30 BMI z-score: As BMI (calculated as weight/height²) changes rapidly in childhood, and
31 growth patterns differ between boys and girls, BMI will be converted to z-score based on the
32 international child growth reference.⁵¹ This method allows for direct comparison of BMI and
33 its changes across different ages and genders.
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38 Parental health

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40 Mental health: Depression Anxiety Stress Scale (DASS) has 3 subscales, each with 7 items
41 rating the severity/frequency of symptoms of stress, anxiety and depression respectively. The
42 total score of each dimension can be categorized as "normal", "mild", "moderate", "severe",
43 and "extremely severe", according to the DASS manual⁵². DASS also has well-established
44 psychometric properties⁵² and been validated in Chinese population (Cronbach's alpha: 0.80
45 to 0.82).⁵³
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52 Quality of life: The SF-12 Health Survey-Version 2 (SF-12v2) is a 12-item quality of life
53 assessment instrument, producing 8 subscales and 2 composite summary scores. The Chinese
54 version of SF-12v2 has been validated and normed in local Chinese population with
55 Cronbach's alpha coefficient ranging from 0.60 to 0.89.^{43 54 55}
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4 Allostatic load index: A review of literature has identified a set of physiological parameters
5 that can reflect AL and yet be conveniently measured, including blood pressure, heart rate,
6 BMI, waist-to-hip ratio, lipid profile, fasting glucose and glycosylated haemoglobin.¹⁸ This
7 set of physiological parameters will be measured and included in the calculation of AL index
8 in this study. An index score of AL is calculated by summing the number of parameters that
9 fall into the abnormality category defined by local clinical practice guidelines.
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16 Screening for depression: Patient Health Questionnaire – 9 (PHQ – 9) is used to screen for
17 depression in the parents. The Chinese version of PHQ-9 has been validated and used in
18 previous local studies (Cronbach’s alpha: 0.82).⁴³
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22 Family and neighborhood environment

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24 Family environment: The Chinese version of Family Harmony Scale – 5 (FHS-5) will be
25 used to measure family harmony (Cronbach’s alpha: 0.92).⁵⁶ Parental risk of physically
26 abusing and neglecting children as well as their parenting style will also be assessed with the
27 Child Physical Assault and Neglect subscale of the Parent Child Conflict Tactics Scale
28 (CTSPC) (Cronbach’s alpha: 0.77 to 0.88)⁵⁷ and the Authoritative Parenting Style subscale
29 of the Parenting Style and Dimension Questionnaire (PSDQ) (Cronbach’s alpha: 0.71 to
30 0.97),^{58 59} respectively.
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37 Neighborhood: The Chinese version of Neighborhood Collective Efficacy Scale (NCES) is a
38 10-item scale, with five items each on informal social control and social cohesion
39 (Cronbach’s alpha: 0.63).⁶⁰
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44 The following socio-demographic characteristics will be considered to be potential
45 confounding factors on the basis of their potential associations with parental stress and child
46 health: household income, children’s age and gender, and parental age and gender, education
47 level, occupation, marital status, and immigration status. Parental history of smoking,
48 drinking and illicit drug use, occupation and marital status, comorbidities of parents and
49 children, and household income will be recorded at baseline and follow-ups. The cognitive
50 abilities of the child from each household were assessed by a clinical psychologist using the
51 Wechsler Intelligence Scale for Children Fourth Edition – Hong Kong (Short Form)
52 (WISC-IV-HK-SF) at the time of enrollment into the main cohort study. Data on such
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3 estimation of intelligence quotient (I.Q.) of the children will be retrieved and used as a
4 confounder in the study.
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7 8 **Data processing and analysis**

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10 Descriptive statistics will be used to summarize the characteristics of parents and
11 children at baseline and each follow-up time point. Parents with a cut-off score of ≥ 15 in
12 stress dimension of DASS will be considered as having at least mild stress as referenced by
13 the DASS manual⁵². Missing data will be handled using full information maximum
14 likelihood in the estimation of path models. This method is robust against biases from data
15 missing at random (MAR). Latent growth modelling will be conducted to obtain how the
16 parental stress and child health changes over times. The bidirectional relationship between
17 parental stress and child health over times will be determined using cross-lagged path model
18 (Figure 2).¹³ Mediation and moderation analysis will also be conducted to map out the
19 mechanism by which the variables relate. All analyses will control for a range of confounding
20 factors with the following variables as outcomes/mediators/moderators:
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27 *Primary exposures/outcomes*

- 28 • Child CHQ General Health Perceptions subscale score
- 29 • Parental DASS Stress subscale score
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32 *Secondary outcomes*

- 33 • Child SDQ Total Difficulty score
- 34 • Child DNA telomere length
- 35 • Child BMI z-score
- 36 • Parental allostatic load index
- 37 • Parental SF-12v2 HRQOL scores
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42 *Mediators of the relationship between parental stress and child health*

- 43 • Parental mental health: depression (PHQ-9 score), DASS Depression and Anxiety
44 subscale score
- 45 • Family disharmony measured by FHS-5
- 46 • Child physical assault and neglect potential measured by the Physical Assault and
47 Neglect subscale of the CTSPC
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52 *Moderators of the relationship between parental stress and child health*

- 53 • Authoritative parenting style measured by the Authoritative Parenting Style subscale of
54 the PSDQ
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- 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 recognized 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 allostatic load 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 allostatic load index, which predicts morbidity and mortality.¹⁹ These results will provide the public with evidence of the biological impact of perceived stress on parents.

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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 (e.g. 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, e.g. 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.

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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 behaviors will therefore be proxy-reported by their parents. Despite this limitation, this study not only assesses participants' perceived health status but also uses objective measures such as telomere length measurement and allostatic load 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 generalizable 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.

53 **Ethics and dissemination**

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This study was approved by the institutional review board of the University of Hong Kong – the Hospital Authority Hong Kong West Cluster, Reference number: UW 16-415. The study

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3 findings will be disseminated through peer-reviewed publications and international
4 conferences.
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24 **Acknowledgements**

25
26 We are most grateful to Kerry Group Kuok Foundation (Hong Kong) Limited (KGKF) for
27 their support. We thank the Neighborhood Advice-Action Council (NAAC) and Yat Tung (I/II)
28 Estate Property Management in providing venue for our study. A special thanks to Versitech
29 Ltd for granting us a complementary license to use the OPine Software for data collection in
30 our study. The timely completion of the telephone surveys by the HKU Social Science
31 Research Center is much appreciated. The hard work of our research staff in data collection
32 and analysis must be acknowledged.

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43 **Contributions**

44
45 RSMW, EYTY and CLKL conceived the study concept, developed the funding proposal and
46 applied for funding. RSMW, EYTY, VYG, CKHW, CSCF coordinates the project. EYFW
47 and CKHW developed the statistical analysis plan, and contributed to the interpretation of
48 data. KTST and WHSW provided input regarding the telomere length assay and
49 interpretation aspects of the study. WYC, PI, AFYT provided expert opinion in mental health,
50 child development and family relationship aspects of the protocol respectively. CLKL is the
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3 funding holder of the community family support programme for low-income families in
4 Hong Kong funded by a philanthropic foundation in Hong Kong (Kerry Group Kuok
5 Foundation (Hong Kong) Limited). EYTY is the principal investigator and the grant holder of
6 the Health and Medical Research Fund of Hong Kong (HMRF/14151571). RSMW, EYTY
7 and CLKL initiated the writing of the protocol paper. All authors revised and approved the
8 final version of the manuscript.
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16 17 18 **Funding**

19
20 This study was supported by Kerry Group Kuok Foundation (Hong Kong) Limited and the
21 Health and Medical Research Fund of Hong Kong (HMRF/14151571).
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26 27 **Competing interests**

28 The authors declare no conflict of interest.
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35 36 **Figure legend**

37 **Figure 1.** Study conceptual model. Potential confounders include baseline sociodemographic
38 information (parental age and gender, child age and gender, household income, parental
39 occupation, and marital status), parental history of smoking, drinking and illicit drug use,
40 parental and child history of comorbidities and child cognitive skills.
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45 **Figure 2.** Hypothesized cross-lagged path model predicting child health and parental stress
46 from baseline to 24-months follow-up.
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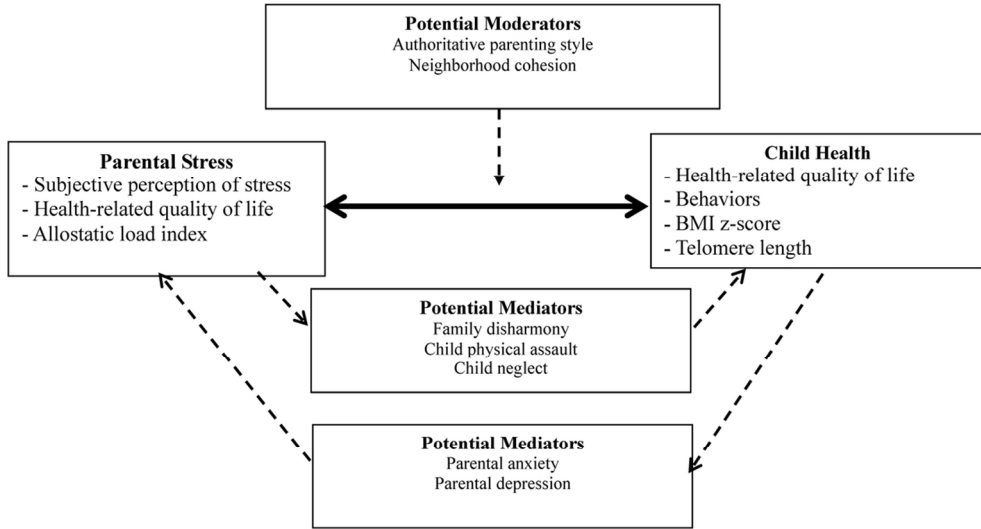


Figure 1. Study conceptual model. Potential confounders include baseline sociodemographic information (parental age and gender, child age and gender, household income, parental occupation, and marital status), parental history of smoking, drinking and illicit drug use, parental and child history of comorbidities and child cognitive skills.

108x58mm (300 x 300 DPI)

Review only

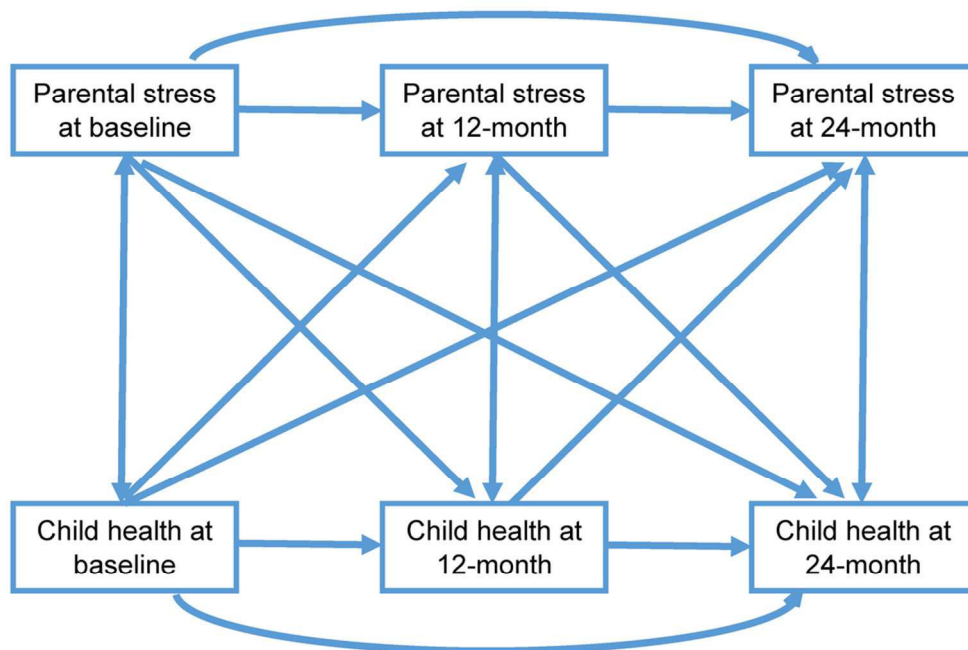


Figure 2. Hypothesized cross-lagged path model predicting child health and parental stress from baseline to 24-months follow-up.

102x68mm (300 x 300 DPI)

Review only

STROBE 2007 (v4) Statement—Checklist of items that should be included in reports of cohort studies

Section/Topic	Item #	Recommendation	Reported on page #
Title and abstract	1	(a) Indicate the study’s design with a commonly used term in the title or the abstract	2
		(b) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4-8
Objectives	3	State specific objectives, including any prespecified hypotheses	8
Methods			
Study design	4	Present key elements of study design early in the paper	8
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8
Participants	6	(a) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	9
		(b) For matched studies, give matching criteria and number of exposed and unexposed	NA
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	14
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	11-13
Bias	9	Describe any efforts to address potential sources of bias	10-14
Study size	10	Explain how the study size was arrived at	9
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	13-14
Statistical methods	12	(a) Describe all statistical methods, including those used to control for confounding	13-14
		(b) Describe any methods used to examine subgroups and interactions	13-14
		(c) Explain how missing data were addressed	NA
		(d) If applicable, explain how loss to follow-up was addressed	13-14
		(e) Describe any sensitivity analyses	NA
Results			

Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	NA
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	NA
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	NA
		(b) Indicate number of participants with missing data for each variable of interest	NA
		(c) Summarise follow-up time (eg, average and total amount)	NA
Outcome data	15*	Report numbers of outcome events or summary measures over time	NA
Main results	16	(a) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	NA
		(b) Report category boundaries when continuous variables were categorized	NA
		(c) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	NA
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	13-14
Discussion			
Key results	18	Summarise key results with reference to study objectives	14-16
Limitations			
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	14-16
Generalisability	21	Discuss the generalisability (external validity) of the study results	14-16
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	21

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at <http://www.plosmedicine.org/>, Annals of Internal Medicine at <http://www.annals.org/>, and Epidemiology at <http://www.epidem.com/>). Information on the STROBE Initiative is available at www.strobe-statement.org.