

School-based Evaluation Advancing Response for Child Health (SEARCH): a mixed longitudinal cohort study from multifaceted perspectives in Jiangsu, China

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ABSTRACT

Background Schools play a crucial role in providing mental health services to children and adolescents. However, the vastness of the student population and mental health workforce shortage in China severely limit the capacity for adequate care access and delivery.

Objective We propose a large, mixed longitudinal cohort study, 'School-based Evaluation Advancing Response for Child Health (SEARCH)', aimed at addressing the increasing demand from individuals seeking access to mental healthcare services.

Methods SEARCH uses a digital platform and school-based protocol for comprehensive assessment of the mental well-being of Chinese students in grades 4–12 incorporating individual, caregiver and teacher input, including capture of facial and acoustic features and response times, as well as mental well-being assessments.

Findings We completed first wave data collection from nearly 20 000 participants (students, caregivers and teachers) at 11 schools, grades 4–12, in 3 cities in Jiangsu province in Southeast China from September 2022 to February 2023. We intend to conduct follow-up assessments for grades 4 through 12 at the 11 school sites every 6 months for 5 years.

Conclusions SEARCH will provide important insight into the developmental trajectory of mental well-being in Chinese children and adolescents. The study protocol does not simply focus on student self-report and incorporates caregiver and teacher viewpoints as well. It also collects objective indicators that may facilitate development of screening tools.

Clinical implications We believe future study findings will guide the development and implementation of school-based mental healthcare initiatives to improve the well-being of children and adolescents.

INTRODUCTION

Mental health challenges among Chinese children and adolescents present a significant concern, with a notable disparity between the growing burden of mental illness and the availability of healthcare resources. A recent comprehensive survey, encompassing a substantial sample of school students aged 6–16 years and

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ The existing literature highlights the limited capacity of school-based mental health services in China, prompting the need for innovative approaches to comprehensively assess the mental health of children and adolescents within the school-centred system.

WHAT DOES THIS STUDY ADDS

⇒ The study contributes a large-scale, rich database for understanding mental well-being across development in children and adolescents and geared towards developing effective screening tools and treatment interventions in face of severe mental health workforce shortages in China.
 ⇒ Through longitudinal tracking, the study gains valuable insights into the dynamics and fluctuations of mental well-being during development, offering a comprehensive understanding of how factors influencing mental health evolve in children and adolescents.

HOW THIS STUDY MAY AFFECT RESEARCH, PRACTICE OR POLICY

⇒ The comprehensive assessment approach adopted in this study provides a guiding model for the development and implementation of mental healthcare initiatives, offering evidence-based insights for enhancing mental health services within schools.
 ⇒ The study's utilisation of digital platforms presents a potential solution to address the current gaps in mental health services in densely populated countries or regions, showcasing the capacity of technology in advancing mental healthcare practices and policies.



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involving over 70 000 participants, sought to assess the prevalence of mental disorders within this population. It found that 17.5% of the young individuals had behavioural and emotional problems.¹ As a result, it becomes imperative to prioritise research efforts directed towards the formulation of effective public health policies and in-depth scientific investigations into the underlying pathological mechanisms, aiming to effectively address these pressing concerns.

Developmental psychopathology within the general population may provide important insights into typical child and adolescent development and identify significant factors or indicators of current or future mental health issues.² Environmental, social and family system factors interact with an individual's genetic and psychological vulnerability in the development of psychopathology and mental illness. Examining the influence of these various factors and their interactions is critical for understanding the development of psychiatric disorders. Thus, large, longitudinal cohort studies that incorporates child, caregiver and teacher input are warranted to capture the slow and non-linear trajectory of psychopathology and discern typical and problematic course of mental well-being in the general population. More severe psychopathology are often preceded by mixed and non-specific presentation of symptoms such as depression or psychotic-like experiences, for which their frequency and significance during development is not well understood.³

However, existing cohort studies focused on understanding the determinants of adolescent mental health typically concentrate on specific aspects of the national or regional adolescent population, such as the three UK population cohorts (1999 British Child and Adolescent Mental Health Survey, 2004 British Child and Adolescent Mental Health Survey).⁴ Additionally, a cross-sectional cohort study conducted within school settings included a total of 12 108 adolescents from 18 secondary schools in Suzhou city, China, and explores the mental health status of transgender or gender non-conforming adolescents.⁵ However, this cross-sectional focus limits their utility in investigating the aetiology and course of adolescent mental health problems. Previous longitudinal studies, such as the 'TRacking Adolescents' Individual Lives' cohort in the Dutch,⁶ the iBerry study in the Netherlands,⁷ the Youth and Mental Health Study in Norway⁸ and the ABCD study in the USA,⁹ have often followed the fixed cohorts of adolescents over years, which is beneficial for tracking individual development and determinants of psychiatric disorders. However, while these studies are highly informative, they may not fully capture other group or generational characteristics such as those related to shared school environments or regional events impacting mental well-being. These factors may also be valuable in understanding how child and adolescent mental well-being is shaped across time. In contrast, the Future Proofing Study adopts a school-based recruitment approach and assesses year 8 students in different years, incorporating an embedded randomised controlled trial experiment for follow-up.¹⁰ While this design partially addresses cohort effects, its utility in managing adolescent mental health is limited.

The establishment of a comprehensive system for child and adolescent mental health services in China is urgently needed. However, such efforts are hampered by limited understanding of how psychopathology evolves in the general population and the extreme mental health workforce shortage for China's vast population of 1.4 billion individuals. As digital technology continues to advance rapidly and becomes universally available, it holds significant potential to provide essential support in settings where accessing clinic-based or hospital-based mental healthcare is challenging or where significant stigma prevents individuals from seeking such care. This scalability is particularly

vital in a densely populated country like China. Thus, we initiated the School-based Evaluation Advancing Response for Child Health (SEARCH) mixed longitudinal cohort study in the province of Jiangsu, China that will span 5 years, which use a digital platform designed by our research team. The primary research questions guiding this cohort study are as follows:

- ▶ How do individual, family and school factors interact and influence the development and persistence of mental health problems during adolescence?
- ▶ What are the trajectories of mental health outcomes among adolescents over time, and what factors contribute to the variations observed in these trajectories?
- ▶ How can the findings derived from this mixed longitudinal cohort study inform evidence-based policies aimed at promoting optimal mental health among adolescents at both the school and family levels?

METHOD

Study design, population and recruitment

This school-based cohort study represents strong collaboration between study investigators (oversight of the project), the Institute for Child and Adolescent Health Promotion at the Jiangsu Provincial Center for Disease Control and Prevention (CDC) (site selection and coordination) and local field investigators (data collection), fostering a school-based alliance for children and adolescent mental well-being.

SEARCH tracks the emotional well-being, sleep and risk behaviours, family environment and trauma exposure, and academic performance of primary and secondary school students aged 10–18 years, spanning grades 4–12 and obtains student facial expression and acoustic samples for future development of screening tools and interventions at first wave and every 6 months thereafter over 5 years. Notably, for each participating school, all students enrolled in grades 4–12 at the time were and will be invited to take part during each wave of data collection, which will occur at 6-month intervals across 5 years; therefore, SEARCH examines school-based grade cohorts that may vary over time as new students are enrolled and others leave due to moving or graduation. Furthermore, the study gathers caregiver and teacher perspectives of individual students for a school and family system view of student participants and to understand the interplay between student self-reports and observed behaviours.

The sampling procedure for this research involved a two-stage approach. In the initial stage, invitations were sent to the CDC departments of three survey cities situated in different regions of Jiangsu province (ie, northern, central and southern regions). For a visual representation, figure 1 illustrates the SEARCH survey site located in Jiangsu province. These departments subsequently disseminated comprehensive information about the SEARCH programme, outlining its objectives, study design and programme details, to all primary and secondary schools within their respective jurisdictions. Out of the approached schools, a total of 11 schools expressed their willingness to participate in the cohort study.

Following the schools' involvement, a comprehensive statement was provided to the primary caregivers of eligible students, clearly explaining the objectives of the mental health surveillance, along with an informed consent form. Prior to data collection, the school received a final list of participating families and students who had given their consent for the mental health surveillance. A total of 11 427 students were recruited for the study at baseline. The first wave of data collection began on 28 September 2022, and data collection was conducted in

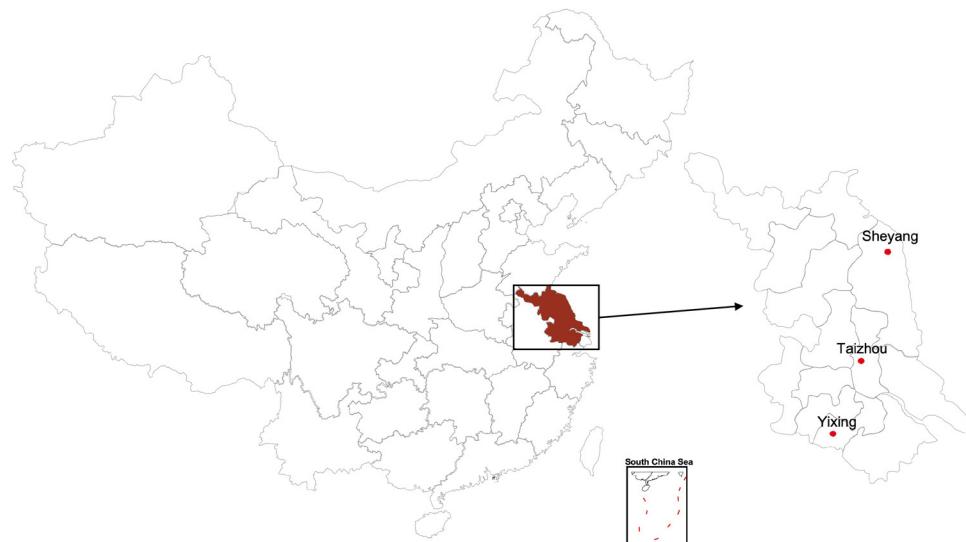


Figure 1 Location of three survey sites in Jiangsu province, China.

three cities in Jiangsu province: Sheyang (three schools, from 28 September 2022 to 1 November 2022), Yixing (four schools, from 27 December 2022 to 21 February 2023) and Taizhou (four schools, from 15 November 2022 to 28 February 2023).

Procedure

Trained field investigators ensured correct operation of the digital platform for data collection and supervised data collection at all sites. Standardised procedures were used across all participants and sites to ensure consistency in data collection. At each site, students first completed questionnaires using the 'SEARCH' website designed by our research team on computer in the school's computer classroom. Then, trained locally field investigators had each student go to quiet classrooms and facilitated collection for facial and acoustic samples using the 'SEARCH' app on an Android tablet.

Following the completion of data collection from students, caregivers were prompted to complete questionnaires regarding their child's mental health and family dynamics. Concurrently, teachers were asked to complete questionnaires for students who met threshold scores on the Depression, Anxiety and Stress Scales-21 (DASS-21) indicating subhealth mental well-being: DASS-21 depression score >9 , DASS-21 anxiety score >7 or DASS-21 stress score >14 . Teachers received a list of students with subhealth mental well-being as determined by DASS-21 and completed questionnaires accounts. Both teachers and caregivers completed their questionnaires using the 'SEARCH' applet configured for WeChat on their mobile phones. For the entire study period, an administrator from study investigators will monitor data collection from all respondents. **Figure 2** provides a visual representation of the comprehensive assessment process employed in the SEARCH study.

Measures

Demographics, family structure and academic performance

We obtained student's age, sex and ethnicity and details regarding their family structure for sample characterisation and general understanding of each student's family unit. We also inquired about students' academic performance, including recent improvements or setbacks, and involvement in class leadership roles. School performance can serve as an early

indicator of potential challenges. A summary of the full list of measures administered is shown in online supplemental table S1.

Student questionnaires on emotional well-being, sleep and risk behaviours, family environment and trauma exposure

Study assessments were selected based on factors of interest that reflect child and adolescent mental health across development, such as DASS-21, Strengths and Difficulties Questionnaire (SDQ) and Insomnia Severity Index as tools for evaluating students' emotional well-being and sleep were included. Also, Family Environment Scale (FES) and Childhood Trauma Questionnaire-28 Item Short Form were used to assess family environment and trauma exposure. Also, assessment of risk behaviours as self-harm and suicidality, bullying, physical activity, screen usage, smoking and alcohol use were made, and their validity and reliability for use in Chinese for students aged 10–18 years, as supported by the literature. They consist of the Ottawa Self-Injury 2 Inventory, Olweus Bully/Victim Questionnaire, International Physical Activity 3 Questionnaire Short Form, Screen Time, Smartphone Addiction Inventory 4, Yale Food Addiction Scale V.2.0 and questions about start time, five frequency of smoking and drinking behaviours. Further details can be found in online supplemental table S1.

Caregiver questionnaires on emotional well-being about student and family environment

Information about child and adolescent mental health from a viewpoint of caregiver, including emotional well-being, in addition to family environment factors and adaptive functioning was collected. SDQ and FES were designed as assessment tools aimed at quantifying the intensity of emotional symptoms on students and family environment styles.

Teacher questionnaires on emotional well-being about student

We asked families for permission to have their students' teachers complete the SDQ-Teacher Form at each assessment wave.



Main Flow of SEARCH

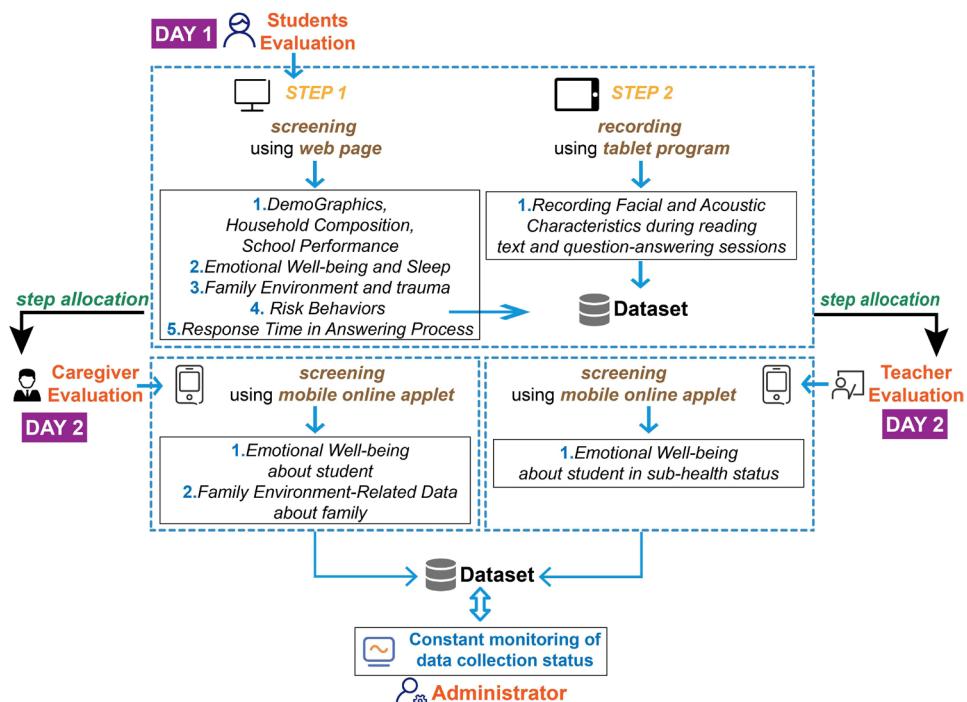


Figure 2 The School-based Evaluation Advancing Response for Child Health (SEARCH) service model involves digital screening for students, step allocation to caregivers and teachers' assessment and assessment monitoring via digital platform.

Facial and acoustic recording

Real-time emotions are conveyed in facial expressions and acoustic features. Subtle nuances in voice modulation, such as a slow and monotonous tone, may signify a low mood, while a stoic facial expression may hint at anger. This realm of investigation carries considerable significance as it delves into the intricate interconnections between verbal and non-verbal emotional cues.

To investigate this further, we employed a methodological approach involving three open-ended questions and a standardised text. We used three open-ended questions to employ the thought-listing technique, which allow participants to describe their mental state in their own words and respond in a manner more closely aligned with their real-life situations and experiences. A prior study used natural language processing method-latent semantic analysis, to leverage open-ended questions for detailed capture of one's real-world behaviour.¹¹ Additionally, the standardised reading text are also often used for speech analysis.¹²

In a quiet, door-closed classroom, field investigators guided students to their designated seats, facing an Android tablet equipped with the pre-installed 'SEARCH' app. Only the field investigator and student were present in the room. To ensure accurate identification, students' identities were confirmed via QR code scans linked to their respective accounts. Subsequently, students followed the app's prompts, ensuring that their faces were properly centred on the screen as they thoughtfully responded to the three open-ended questions. The open-ended questions comprised neural, negative and positive aspects, such as "Please describe how you spent yesterday?" and "Please describe the happiest/saddest memory you can think of right now from the last week?"; alongside queries prompting the recollection of the happiest and saddest memories of the past week. Each question is allocated a time limit of 60 s, and the recording process

automatically ceases on reaching the designated time threshold. Additionally, students were requested to read aloud a brief passage entitled 'The North Wind and the Sun', extracted from the Handbook of the International Phonetic Association, within a 60 s timeframe. Following the completion of the three open-ended questions and the standard text reading task, students are required to click 'Save Recording' once more to store the recorded facial and acoustic data within the tablet's local database. The recordings were saved in mp3 and m4a format files, with prior testing to ensure uniform format and parameters. During the recording, the trained field investigator ensures that the student's upper body remains centred on the display screen, facing both the electronic screen and the microphone, and maintains a 20 cm distance from the microphone to ensure recording quality. In cases of unexpected interruptions, students have the option to re-record.

Response time intervals

Participants may rush through questionnaires without careful consideration, leading to potential biases in their answers, or they may present themselves in a more favourable manner, affecting data accuracy.¹³ Researchers have implemented methodologies to address these concerns, using screening questions, repetitive inquiries and neutral language to mitigate biases.¹⁴ For more accurate analyses, objective response behaviour detection methods, such as recording response times in online surveys, are essential in assessing genuine attitudes and preferences of participants. These response time intervals offer insights into participants' answer processing and can enhance the validity of data collected in survey-based research.¹⁵

The questionnaire responses for SEARCH were gathered using a digital-based platform designed by our research team. For each questionnaire item, the platform displayed one question at a

Table 1 Demographic characteristics of the SEARCH study participating in first wave

	Students (n=11 427)	Caregivers (n=8839)	Teachers (n=1656)
Location			
Survey site 1	4180	2897	262
Survey site 2	3880	3420	862
Survey site 3	3447	2522	532
Educational level			
Primary school (grades 4–6)	3209	2907	317
Junior high school (grades 7–9)	4353	3045	934
Senior high school (grades 10–12)	3865	2887	405
Sex			
Male	6083	2387	–
Female	5344	6452	–
Race			
Han	11 284	–	–
Ethnic minorities	143	–	–
Standardised text	8269	–	–
Open-ended questions_1	8201	–	–
Open-ended questions_2	8200	–	–
Open-ended questions_3	8253	–	–
Response time interval	11 427	8839	1656
SEARCH, School-based Evaluation Advancing Response for Child Health.			

time. When the question page appeared, the system recorded the first timestamp. After participants selected their answers, the system recorded a second timestamp. The time interval between these two timestamps represents the response time intervals for each question. Using objective response time measures can prove to be a valuable method to enhance data quality and bolster the validity of digital mental health screening studies.

RESULTS

The investigation yielded remarkable results, encompassing a substantial cohort of 11 427 students, 8839 caregivers and 1656 teachers at first wave. To ensure a representative and diverse participant selection, the study employed a meticulous stratified cluster sampling technique. This comprehensive sampling approach bolsters the generalisability and robustness of the study's findings.

Table 1 provides an informative overview of the demographic characteristics observed within the SEARCH study cohort. Student participants consisted of a total of 3209 primary school students, 4353 junior high school students and 3865 senior high school students. Approximately 98% of the student participants belonged to the Han Chinese ethnicity, while 143 students represented ethnic minorities. Caregivers had a commendable response rate of 77.35%, which provides a more holistic understanding of the student participants.

Samples of student facial expression and acoustic data were obtained during their response to three open-ended questions and their reading of standardised text using the SEARCH apps on tablets. There was a data dropout rate of 27%–28% due to some students failing to save their responses in the SEARCH application and the mass COVID-19 outbreak at the Yixing and Sheyang school sites. Consequently, the final dataset consists of 8269 records or 72.4% completing reading the standardised text, 8201 records or 71.8% completing response to open-ended question 1, 8200 records or 71.8% completing response to

open-ended question 2 and 8253 records or 72.2% completing response to open-ending question 3.

DISCUSSION

The SEARCH cohort study will involve schools, families and local disease control departments in a collaborative manner. Furthermore, the study boasts a substantial participant cohort of approximately 20 000 individuals, effectively integrating a diverse array of data sources. The study ensures a comprehensive evaluation of student participants by adopting a mixed longitudinal paradigm that includes multiple assessments related to mental well-being in children and adolescents, and collects input from caregivers and teachers. Employing digital technology, the study uses a digital monitoring platform to efficiently administer assessments to participants, streamlining and accelerating the data collection process.

Chinese authorities have urgently prioritised improving and sustaining mental health literacy among children and adolescents as a crucial measure to enhance the nation's overall mental health, with particular emphasis on the pivotal roles played by school and family environments in fostering healthy mental development during adolescence. Presently, studies in other countries have also explored diverse approaches to augmenting school psychological services, including the implementation of digital platforms to enhance efficiency or the introduction of short-term psychological interventions.^{16 17} Despite these efforts, there remains a lack of dedicated resources for comprehensive digital mental health initiatives within educational settings. In this context, the SEARCH cohort study emerges as an exemplary model, effectively integrating digital mental health services within school environments and providing valuable insights to inform the development of preventive strategies and advance public health policies. The SEARCH study cohort, characterised as a dynamic mixed longitudinal cohort, affords a distinctive advantage by facilitating the tracking of longitudinal mental health trajectories in the same group of children and adolescents, while also incorporating diverse groups at different time points. Additionally, this cohort offers three common perspectives, each contributing unique insights into the state of mental health among children and adolescents.

Mental disorders, influenced by biological, psychological and social environmental factors, involves complex brain dysfunction and may lead to changes in academic performance. For accurate and early identification of mental subhealth in children and adolescents, it is essential to systematically evaluate physiological indicators that effectively reflect and predict mental health. The SEARCH study collects and analyses measurable features of emotions, such as facial data, acoustic features and response time, to ensure data objectivity and reliability for the development of objective and accurate screening methods. Additionally, we hope to use the database to help enhance screening, diagnosis and treatment monitoring. We have performed similar work previously for online cognitive behavioural therapy,¹⁸ identifying potential acoustic markers to monitor treatment response to online or remote interventions.

However, the SEARCH cohort study has certain limitations due to its localised recruitment in Jiangsu province, China, leading to potential homogeneity issues and cautious interpretations when applying findings to child and adolescent mental health at large. The proportion of Han Chinese in the initial sample was 98%, limiting the ability to generalise the findings to other ethnic groups within China or globally. Furthermore, this study was in the general population and not in a clinically



high-risk or clinical population. Thus, the relative frequency of problematic symptoms or behaviours are likely lower in this study, and findings may not be readily applicable to psychiatric disorders. However, previous studies in general populations have provided helpful insights into risk factors, phenomenology and the physiology of mental disorders.¹⁹ To fully validate the SEARCH model, future studies should adopt a nationwide approach with a broader participant pool. Additionally, the lack of biological samples in the study restricts exploration of genetic factors' influence on mental health, prompting the design of a saliva sample collection protocol in the third-stage data collection for a more comprehensive examination of genetic contributions. Importantly, the impact of COVID-19 varied across sites due to the timelines of first wave measures. For the first wave, data were collected in different timeframes at school sites from 28 September 2022 until 28 February 2023, during which COVID-19 restrictions were relaxed on 5 December 2022. Study analyses will need to consider the differential effects of the COVID-19 pandemic across the different timeframes for data collection and mental health trends before and after widespread COVID-19 infection, including long-term effects of COVID-19 infection.

Overall, the SEARCH cohort study presents a substantial school-centred approach to comprehending and tackling mental health concerns in primary and secondary school students, using the internet's attributes to create an efficient online screening system for high-risk groups. Its outcomes and methodology hold significance for mental health research, offering insights that can guide the formulation of effective interventions and policies to promote the well-being of children and adolescents.

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Contributors FW is responsible for the overall content for the SEARCH study, had access to the data, and controlled the decision to publish. RZ and YW coordinated the study at all stages and drafted the manuscript. FY.W reviewed the manuscript draft and supervised the study design. WY and XW supervised data collection at the survey sites. XZ, XX and ZS coordinated and supervised the digital platform at the study. LW, JZ, SQ, KYZ, FL and XY.Z conducted preparation of prework and questionnaires. FW, JY and XZ formulated the research question, the conception and design of the study, obtained the funding and guided the study at all stages. YL guided the sample collection at all stages.

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Patient consent for publication Not applicable.

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