

BMJ Open Comprehensive workplace intervention for cancer prevention in China (WECAN): protocol for a stepped-wedge, cluster-randomised controlled trial

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ABSTRACT

Introduction Cancer is the second leading cause of death across the globe with the majority of deaths occurring in low-income and middle-income countries. Evidence has shown that the cancer burden can be substantially reduced by avoiding behavioural risk factors through comprehensive intervention strategies, including workplace health promotion, which has shown to be cost-effective in developed countries while rarely conducted in developing countries. This study aims to explore a feasible and sustainable approach to the prevention and control of cancer in China by developing an evidence-based comprehensive workplace health model equipped with a smartphone application for implementation.

Methods and analysis This study is designed as a stepped-wedge, cluster-randomised controlled trial. We will recruit 15 workplaces from three cities in China. A total of 750 employees will be randomly selected for evaluation that includes five rounds of survey conducted every 6 months. After the second evaluation, workplaces will be randomly allocated to start the intervention sequentially every 6 months in three steps with five workplaces per step. A mobile application 'Healthy Workplace' will be developed to support the intervention. On-line and off-line health-related activities will be carried out among employees. Employers will provide supportive policies, environment and benefits to facilitate the adoption of healthy behaviours. The primary outcome is the change of Healthy Lifestyle Index Score, which consists of five components including smoking, alcohol drinking, physical activity, diet and body mass index.

Ethics and dissemination The study has been approved by Queen Mary University of London Ethics of Research Committee (QMERC22.257) and Chinese Centre for Disease Control and Prevention Institutional Review Board (202210). Written informed consent is required from all participants. Results will be disseminated through presentations, publications and social media.

Trial registration number ChiCTR2200058680.

INTRODUCTION

Cancer is the second leading cause of death around the world, killing 9.6 million people each year, with 70% of these deaths occurring

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This study will develop an innovative application-based comprehensive workplace health model to explore a feasible and sustainable approach to the prevention and control of cancer.
- ⇒ This implementation research will apply the Health Action Process Approach (HAPA) in the development of individualised interventions and follow the Reach, Effectiveness, Adoption, Implementation and Maintenance (RE-AIM) framework to conduct an overall evaluation of the intervention and implementation strategies.
- ⇒ The study design of a stepped-wedge, cluster-randomised controlled trial will deliver interventions to all workplaces sequentially, which may increase the challenge of delivering the interventions as scheduled but will improve the participation of workplaces and facilitate the quality control and project management.
- ⇒ Community engagement will be fully considered throughout the study by involving employers and employees in the whole development and implementation of the project.
- ⇒ The study will be carried out in China only; however, the study sites will be in low-income and middle-income regions of China, meaning that the work has potential to be adapted by other low-income and middle-income countries that share similar lifestyle and dietary habits in resource-constrained settings.

in low and middle-income countries (LMICs).¹ It is reported that one-third of the global cancer deaths are attributable to modifiable behavioural risk factors, such as tobacco and alcohol use, unhealthy diet, obesity and lack of physical activity.² Worldwide, 19.2% of the population (1.4 billion) use tobacco, 27.5% are insufficiently physically active, 39% are overweight/obese, over two-thirds of adults in LMICs consume inadequate amount of fruit and vegetables, and almost all adults in the world have an excessive intake of salt.^{3,4}

All these constitute the common risk factors of many non-communicable diseases (NCDs) including cancer.

Evidence has shown that the cancer burden can be substantially reduced by avoiding behavioural risk factors through comprehensive intervention strategies, such as health promotion in the workplace that has been widely conducted in developed countries.^{5,6} In the USA, the Working Well Trial funded by the National Cancer Institute in 1989 indicated that the 2-year intervention in workplace for cancer prevention resulted in a significant improvement in diet and a positive trend in tobacco control.⁷ A non-governmental organisation named 'The CEO Roundtable on Cancer' was reported to have helped hundreds of companies to establish healthy workplace for cancer prevention and control.⁸ The American Centre for Disease Control and Prevention (US CDC) has developed a workplace health model to roll it out across the country.⁹ In the United Kingdom, National Institute for Health and Care Excellence issued a series of guidance and pathway for healthy workplace.¹⁰ Workplace health promotion is reported to have produced US\$2.5 to US\$10.1 savings for every dollar invested, and participants had 25%~30% lower medical and absenteeism costs compared with non-participants over an average study period of 3.6 years.¹¹

The common features of the above-mentioned workplace cancer prevention models are: (1) the core components usually consist of comprehensive pillars such as tobacco control, healthy diet, physical activity promotion and cancer screening; (2) employers and employees are both encouraged to be engaged; (3) behaviour change theories and social environment models are widely considered in implementation. In addition, information technologies have been increasingly applied in cancer prevention. For example, the *Your Disease Risk* web provides Americans with a self-risk assessment for 12 cancers and six other chronic diseases.¹² Smartphone applications have been explored in the prevention of breast cancer across 20 countries.¹³

In contrast, LMICs are lagging behind in workplace health promotion for the prevention of cancer despite the fact that the high burden of cancer has challenged the weak health system of these countries. In China, the cancer deaths accounted for 36.2% of the premature deaths in 2018, with 45.2% of all cancer deaths attributable to 23 potentially modifiable risk factors.¹⁴ Prevention of occupational diseases is usually prioritised over NCDs in workplaces following the Chinese law on the occupational disease precaution and treatment effective in 2002.¹⁵ Only a few international companies and large state-owned work units in China have administered holistic health management for staff. The majority of the local companies and small and medium-sized work units have little exposure to cancer prevention intervention; this is particularly the case for those workplaces located in low-income and middle-income regions of China. As such, this study (named WECAN, comprehensive Workplace intervention for CANcer prevention) aims to adapt the evidence-based strategies of workplace health

promotion and explore the smartphone application-supported comprehensive interventions in the prevention and control of cancer in workplaces of China and build a scalable model feasible for China and adaptable for other LMICs in order to reduce the burden of cancer across the globe.

METHODS AND ANALYSIS

Design and timeline

This study is designed as a stepped-wedge, cluster-randomised controlled trial. Standard Protocol Items: Recommendations for Interventional Trials reporting guideline was used as the guidance for the protocol.¹⁶ The duration of the project is 48 months. It consists of three phases as shown in [table 1](#).

Phase 1 (12 months): preparation and enrolment

We will obtain ethical approval, recruit workplaces, develop and pilot the intervention package including the 'Healthy Workplace' app to be used for data collection and intervention.

Phase 2 (24 months): staggered intervention

The 15 workplaces will enter the intervention sequentially every 6 months in three steps with five workplaces per step. All workplaces will receive the intervention over the course of the study, which is likely to increase their participation in the project. This design could also reduce the difficulties of implementing a programme simultaneously in many workplaces, which will facilitate quality control and project management.

Phase 3 (12 months): analysis and scale-up strategy development

We will conduct analyses to evaluate the effect of intervention, the implementation outcomes as well as economic benefits, and develop a scalable strategy for national roll-out.

Setting

WECAN will be undertaken in three cities from three provinces of China including Xiangtan city of Hunan Province, Nanchong city of Sichuan province and Wuhai city of Inner Mongolia. These selections are made considering: (1) relatively high incidence of cancers including lung, stomach, liver, oesophageal, colorectal and breast cancer; (2) the local economy is in the low and middle level of the country, and this study, thus, can support the cancer prevention in developing regions; (3) geographical distribution, with Inner Mongolia, Sichuan and Hunan province located in the north, central and south region of China, respectively, which can test the adaptability of our intervention across various regions with different diets and lifestyles and (4) previous experience in cancer prevention and workplace-related work and cooperative willingness of local partners, that is, local Centres for Disease Control and Prevention (local CDCs).

Table 1 Stepped-wedge design and timelines of the project

Phases→	Preparation and enrolment		Staggered intervention				Analysis and scale-up strategy	
	January–June 2022	July–December 2022	January–June 2023	July–December 2023	January–June 2024	July–December 2024	January–June 2025	July–December 2025
Workplaces↓								
A1								
A2								
B1								
B2								
C1								
A3								
A4								
B3								
C2								
C3								
A5								
B4								
B5								
C4								
C5								

Intervention
 Control.

Note: A, B and C represent three selected cities, respectively.

Recruitment of workplaces and participants

Workplaces

- ▶ **Inclusion criteria of workplaces**
 1. Number of full-time employees > 100.
 2. Average turnover rate of past 3 years < 20%.
 3. Employer agrees to participate in the study and supports the implementation of the project.
 4. Regular employee health examination provided.
- ▶ **Exclusion criteria:** no specific exclusion criteria for workplaces.
- ▶ **Recruitment method:** workplaces will be recommended by local CDCs, then the project team will conduct preliminary screening through on-site or remote assessments.

Participants (employees)

Employees participating in the ‘intervention’ (workplace cancer prevention intervention)

- ▶ **Inclusion criteria for intervention**
 1. All employees in the recruited workplace will receive the intervention.
 2. Employees who agree to receive the intervention through smartphone applications.
- ▶ **Exclusion criteria:** no specific exclusion criteria for individuals.
- ▶ **Recruitment method:** employees will be mobilised to join the intervention activities through staff meetings, workshops and other means of publicity.

Employees participating in the ‘evaluation’ (evaluation of the effectiveness of interventions)

- ▶ **Inclusion criteria for outcome assessment**

Employees who

 1. meet the inclusion criteria for participation in the ‘intervention’.
 2. are able to ensure regular attendance of work.
 3. have no plan of retirement or quitting the job in the next 3 years.
 4. consent to be surveyed on the outcome assessment and sign the informed consent form.
- ▶ **Exclusion criteria**

Employees who

 1. had been diagnosed with cancer.
 2. are pregnant or preparing for pregnancy.
 3. have other physical, psychological or social reasons for not being able to participate in the assessment survey.
- ▶ **Recruitment method:** each workplace will randomly select 50 employees among all eligible employees at the workplace to participate in the assessment.

Randomisation

Randomisation will be carried out using computer-generated random number by an independent statistician who is blind to the identity of the workplaces. The randomisation of workplaces will take place after baseline data collection has completed. Five workplaces from

three cities will be randomised to start the intervention sequence each time, while ensuring that at least one to two workplaces from each city will be included in each step. The researchers and workplaces will be aware of the randomisation at the start of the first intervention sequence. The 50 employees in each workplace will be randomly sampled in the proportion of the distribution of gender (male vs female), age (<40 years vs ≥40 years) and types of work (workers in the production workshops vs staff working in the office) of the eligible employees in the 15 workplaces.

Intervention

Intervention model and theory

Workplace health model developed by US CDC will be adopted in our study to guide the development and implementation of comprehensive interventions.¹⁷ Following this model, we will: (1) carry out workplace health assessment for the enrolled workplaces, (2) work with the workplace to develop a customised health improvement plan, (3) implement the plan through the intervention components described below and (4) assess the impact. Both employers and employees at each workplace will be involved throughout the project. A health committee led by the workplace leader will be set up at each workplace, coordinators will be appointed, and training and workshops for both employers and employees will be organised, for example, healthy diet workshop.

The Health Action Process Approach (HAPA) will be applied to guide the design of the interventions. HAPA

suggests that behaviour change is a continuum from no intention through intention to action.¹⁸ At baseline, we will collect information on participants' intentions to change in relation to cancer-related risk factors. For those without intention to change, the intervention will focus on health literacy education towards cancer risk awareness, outcome prediction, etc. For those who intend to change, the intervention will target behavioural interventions and motivation. For those who already have adopted certain healthy behaviours, interventions will focus on reinforcing the message to prevent the recurrence of unhealthy behaviours.

Intervention components

According to the workplace health model of US CDC,¹⁷ the strategies and interventions will consist of four categories: (1) health-related policies (formal or informal written statements that are designed to protect or promote employees' health); (2) environmental support (provide physical facilities in and nearby the workplace that help protect and promote the health of employees); (3) health-related activities (opportunities available to employees at the workplace or through outside organisations to begin, change or maintain health behaviours) and (4) health benefits (subsidies and other services or discounts regarding health). A customised workplace health promotion plan will be developed in each workplace with required core components and optional additional components under the categories (table 2).

Table 2 Core and additional components of the intervention strategies

Interventions	Core components	Optional components
Health-related policies	<ul style="list-style-type: none"> ▶ Workplace health improvement plan developed under the commitment of employers. ▶ Policies prohibiting tobacco at the workplace. ▶ Policies prohibiting alcohol use at the workplace. 	<ul style="list-style-type: none"> ▶ Policies requiring healthy foods to be served in workplaces. ▶ Policies allowing for time on health-related activities. ▶ Improvement of regular medical health check for employees.
Environmental support	<ul style="list-style-type: none"> ▶ Bulletin boards, kiosks and other communication pathways to provide workplace health information. ▶ 'No smoking' logo posted in full position of workplace. 	<ul style="list-style-type: none"> ▶ On-site fitness facilities or walking/running trails or open green space for exercise or relaxation. ▶ Standing desk for preventing long-time sedentary work. ▶ Healthy foods available in cafeteria, snack shops or vending machines. ▶ Provide body weight scale and electronic blood pressure manometer for employees and encourage frequent use at workplace.
Health-related activities	<ul style="list-style-type: none"> ▶ Employees install and use the 'Healthy Workplace' mobile application developed by this project to receive health education, conduct health risk assessments, monitor health conditions and participate in health-related activities. 	<ul style="list-style-type: none"> ▶ Offline activities on fitness, nutrition, stress management and cancer prevention. ▶ Staff club on fitness, sports, hobbies or weight management.
Health benefits	<ul style="list-style-type: none"> ▶ Incentives or bonus for participating in health promotion programmes or achieving individual or group health goals. ▶ Recognitions for healthy behaviours 	<ul style="list-style-type: none"> ▶ Discounts and/or subsidies for healthy foods provided in worksites. ▶ Subsidies for cancer preventive services and cancer screenings.

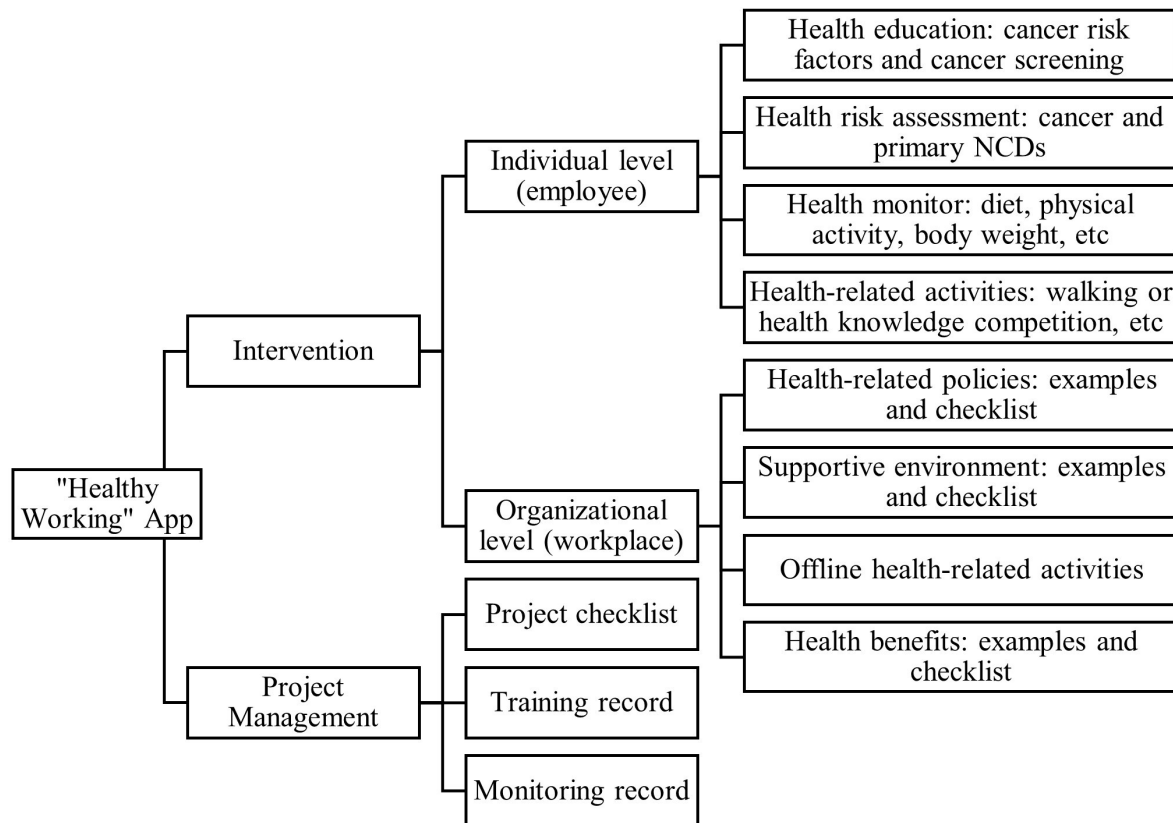


Figure 1 Modules of the ‘Healthy Workplace’ app. NCD, non-communicable disease.

Tools for implementation

The intervention will be delivered through a well-designed mobile app ‘Healthy Workplace’ developed by the research team. The ‘Healthy Workplace’ app is a platform integrating the functions of intervention, evaluation and project management (figure 1). Specifically, individual participants can receive interventions and communicate with peers through the participant end; workplace leader and project members can record relevant activities and manage project through the staff end.

Noteworthy, the intervention activities will focus on the common modifiable cancer risk factors, including smoking, alcohol drinking, unhealthy diet, physical inactivity and unhealthy body weight, although the ‘health education’ module will cover as many cancer risk factors as possible. The app will help implement the recommended interventions to each individual based on his/her specific risk factors and behaviour change intention. Meanwhile, it will also provide recommendations on cancer screening.

Monitoring and quality control

During the intervention period, the local CDC staff will supervise and monitor the progress of the project on a monthly basis, and the project team members will monitor the progress of the project every 3 months. The project team will work closely with the local CDCs to document and resolve specific issues that arise during the intervention in a timely manner to ensure smooth implementation and high quality. Moreover, a steering committee

consisting of six external professionals will be established and meet annually to oversee the high-quality implementation of the trial.

Outcome measures

The primary outcome is the change in modifiable behaviour risk factors of cancer after the intervention. An adapted Healthy Lifestyle Index Score (HLIS) will be used as the indicator. The HLIS, originally constructed from the European Prospective Investigation into Cancer and Nutrition cohort study, was composed of five components: smoking, alcohol drinking, physical activity, diet and body mass index (BMI).¹⁹ Scores of 0 to 4 were assigned to each individual variable category. As such, the HLIS ranged from 0 to 20 with a higher point value indicating a healthier behaviour. HLIS has been used to study the joint effect of multiple lifestyle factors on the risk of cancers and NCDs in multicountries.²⁰ Each increase in HLIS score was associated with 3% to 5% decrease in cancer risk.¹⁹ We will develop a Chinese version of weighted HLIS according to the relevant recommendations of Chinese guidelines and the risk ratio of risk behaviours to cancers in China (table 3).¹⁴

The secondary outcomes include: the change of specific behaviour risk factors of employees, that is, smoking rate, alcohol drinking, physical activity, healthy eating score and BMI; the change of blood pressure, glucose, lipids of employees; the change of employees’ attendance and healthcare costs of organisations; the change in the occurrence of cancer and other major NCDs, for example,

**Table 3** Components of adapted Health Lifestyle Index Score (HLIS)

Component	Score	Weight	Definition in this study
Smoking	0–4	1.75	Never=4, ex-smokers quit>10 years =3, ex-smokers quit≤10 years = 2, current≤15 cigarettes/day=1, current>15 cigarettes/day =0.
Alcohol drinking	0–4	1.15	Men: 0–4.9 g/day=4, 5.0–9.9 g/day =3, 10.0–19.9 g/day=2, 20.0–24.9 g/day=1, 25+g/day=0; Women: none=4, 0.1–4.9 g/day=3, 5.0–9.9 g/day=2, 10.0–14.9 g/d=1, 15+g/day=0.
Physical activity (PA)	0–4	0.65	Metabolic equivalent tasks for four activity domains (job-related PA; transportation PA; PA for housework; sports and leisure-time PA): fifth quintile=4, fourth quintile=3, third quintile=2, second quintile=1, first quintile=0.
BMI	0–4	0.75	<22=4, 22–23.9=3, 24–25.9=2, 26–27.9=1, 28+=0.
Dietary factors	0–4	0.70	*Quintiles of total score of 6 dietary factors (fruit intake, vegetable intake, dietary fibre, red meat, processed meat, salt intake): fifth quintile=4, fourth quintile=3, third quintile=2, second quintile=1, first quintile=0.
HLIS	0–20	Total of weighted five index components	

*Each dietary factor is scored from 0 to 9, with the least healthy score being 0, for example, for salt, the highest intake=0 and the lowest salt intake=9, whereas for fruit and vegetable, the lowest intake=0 and the highest intake=9.
BMI, body mass index.

stroke, heart attacks of employees in the long term. Implementation outcomes are also considered, including the coverage of employees participating intervention activities, the adoption of each intervention components, the fidelity of the implementation and the views of employers and employees towards the implementation.

Sample size calculation

We conservatively assume that the increase of mean HLIS is from 12 to 13 and the SD is 5 in reference to previous study.²¹ The estimated level of this outcome will be tested in the upcoming pilot study of this project. Based on the sample size calculation method proposed by Dr Taljaard and the Shiny CRT Calculator,^{22 23} in this closed-cohort, stepped-wedge design, we assume that the intervention will be divided into three steps of 40 people per step per cluster (workplace), with an intraclass correlation coefficient of 0.05, a cluster autocorrelation coefficient of 0.75, an individual autocorrelation coefficient of 0.8 and a two-sided alpha of 0.05. Therefore, each step of five clusters (workplaces) would have a Power of 0.889. Assuming a 20% dropout rate of participants, at least 50 participants per workplace will be recruited with a total of 750 participants for assessment and evaluation.

Data collection and management

Data collection

Data collection will be carried out by local CDC staff through the project's customised Electronic Data Capture (EDC) system. All the enrolled workplaces and employees will complete a baseline survey and a follow-up survey after a 6-month control period, and then start the intervention steps sequentially. Evaluation data will be collected regularly along with the intervention steps (table 4). With the consent of participating workplace, data collection such as cancer incidence data will continue even after the end of project to examine the long-term effect.

The individual participants will answer questionnaires covering six aspects including demographic information, lifestyle behaviour (smoking, alcohol consumption, physical activity, diet), history of exposure to harmful substances, disease history, family history and reproductive history of women, which was adapted from the cancer risk assessment questionnaires developed by National Cancer Institute of China.²⁴ Body weight, height, waist circumference and blood pressure will be measured at the workplaces.

Table 4 Content and frequency of data collection

Respondent	Content	Baseline	Semi-annually	Annually	End of project
Individual	HLIS questionnaire and physical examination	√	√		√
	Cancer risk assessment	√		√	√
Workplace	Self-evaluated questionnaire	√		√	√
	Cancer incidence data	√		√	

HLIS, Healthy Lifestyle Index Score.

The workplace-level data collection will include self-evaluation questionnaire and cancer incidence data provided by employers. Self-evaluation questionnaire will be adapted from the 2019 Worksite Health ScoreCard developed by US CDC.¹⁷ The ScoreCard is a tool designed to help employers assess whether they have implemented evidence-based health promotion strategies to improve the health and well-being of their employees. Besides, we will also collect the cancer incidence, sick leave and healthcare cost in the preceding year from each workplace.

Data management

The EDC system automatically saves the data and ensures the security, integrity and consistency of the data. Researchers can access and query these data during the process. A data management and sharing plan will be in place at the beginning of the project. We will comply with all legislations relating to privacy of personal and health information. Appropriate technical and organisational security measures will be adopted to ensure data security and protect the personal data against unauthorised disclosure or access. A formal data monitoring committee will not be established in view of the minimal risks of the study.

Statistical analysis

The primary analysis will be carried out according to the intention-to-treat principle. We will assess whether the intervention improves the modifiable risk behaviours of cancer (continuous outcome variable HLIS) of the participants. We will use generalised linear mixed models with appropriate links for the primary analysis considering random effects for workplaces and individual participants and fixed effects of intervention. We will adjust the effect of intervention on HLIS for age, sex, types of work and other potential confounding factors. We will also conduct a series of secondary analyses on the changes of specific behaviour and explore the time effect on the intervention. Multiple imputation will be considered to handle missing data, and sensitivity analysis will be performed to assess the effect of missing data.

Process and implementation evaluation

We will apply the RE-AIM framework to the overall evaluation of intervention and implementation strategy, which consists of five dimensions.²⁵ The reach dimension collects the percentage and characteristics of individuals receiving the intervention; effectiveness evaluates the impact of the intervention, including anticipated and unanticipated outcomes; adoption concerns the percentage and representativeness of settings that adopt the intervention; implementation focuses on the consistency and cost of delivering the intervention and maintenance measures long-term sustainability at both the setting and individual levels.

A mixed-method approach will be used to collect the data in terms of the above dimensions. The major data

sources include: (1) routinely collected monitoring data; (2) app usage log exported from the application system; (3) the human and material resources invested in projects and interventions and (4) semistructured interviews with participants and key informants including employees, project coordinators, employers and local partners.

Health economic evaluation

Return on investment (ROI) and value of investment (VOI) will be estimated.¹¹ Reduced medical costs and increased productivity will be calculated as indicators of ROI. Programme costs and medical claims data paid by work units and sick-leave days of employees will be collected annually. VOI will be calculated to examine the broader impact of the workplace health promotion programme on the core priorities of their organisation. Benefits such as improved employee morale, talent attraction and retention, enhanced company loyalty and improved company image will be estimated from qualitative and quantitative interviews with employers and employees.

Project status

This paper was based on the protocol amendment number of 08 issued on 13 May 2022. As of December 2022, we have completed the recruitment of workplaces and the development of EDC. Due to the COVID pandemic in 2022, the baseline survey in December 2022 is put off to March 2023 with a pilot evaluation survey completed before that. The development of 'Healthy Workplace' app is underway and to be in place in April 2023 followed by a pilot intervention in May. After a 6-month control period of all workplaces since the baseline survey, the second evaluation survey will be carried out in September 2023 and the first sequence of intervention will start from October 2023.

Patient and public involvement

Employers and employees have been and will continue to be fully engaged throughout the project. During the development of the study protocol, we had an online meeting with both the employers and employee representatives to gain their opinion. We also visited several workplaces in person to discuss with the employers about the design of the application and the feasibility of the implementation. We will work with workplaces to develop the intervention plan for each workplace under full assessment of the workplace. The evaluation and intervention will be piloted among employers to further collect their feedback. During the study, both employers and employees will be informed of the study progress and exchange ideas of the project and share experiences through the intervention platform and the project social media account WeChat, which will be sustained to disseminate the research results after the completion of the study.

ETHICS AND DISSEMINATION

The study has been approved by Queen Mary (University of London) Ethics of Research Committee (QMERC22.257) and Chinese Centre for Disease Control and Prevention Institutional Review Board (202210). Cluster-level consent will be obtained from workplace leaders. At the individual level, written consent will be obtained from the employees selected for evaluation. An example participant consent form is found in online supplemental file 1. All participants will be free to discontinue their participation at any time.

The project will use a variety of channels to proactively communicate the key messages of research outputs to stakeholders, for example, the policymakers at the health authorities and the trade unions. These channels will range from social media, press release and media coverage to more targeted channels such as workshop and roundtable event. Globally, our research findings will be disseminated to a broader audience worldwide through publications and the global network of research team.

DISCUSSION

WECAN will provide a novel and feasible approach to achieve the prevention of cancer in the workplace population, who are playing central roles in their families, work units and society. If the comprehensive workplace cancer prevention intervention model with the support of the easy-to-use mHealth platform is proven to be contextually effective, it will provide recommendations on the national cancer prevention policies. The ultimate beneficiaries will extend to millions of workplace population; and the impactful change of the healthy lifestyle will also reach to the communities, families and other settings in the whole society.

According to WHO cancer country profile 2020, China shares a large proportion of global burden of cancer and approximately 180 000 lives are projected to be saved in 2022 if essential cancer prevention services are widely implemented, giving an annual economic cost-saving of exceeding RMB 220 billion (approximately US\$ 31 billion).²⁶ The effective cancer prevention in China will bring about tremendous health and economic benefits in alleviating the global cancer burden.

Although the study is being conducted in China only, the experience from the low-income and middle-income regions of China has a great potential to be adapted by other LMICs that share similar lifestyle and dietary habits in resource-constrained settings.

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Contributors FJH, JW and PZ conceived the project and acquired the funding. They contribute equally to the work. PZ, YLi and FJH designed the study. PZ and YLiu oversaw the conceptualisation and development of the app. KS, YLi, RL and PZ are working on the development of the app. BW, NW and JW facilitate Patient and Public Involvement and are responsible for setting up the study in sites. YLi, PZ, SD and CW contributed to sample size calculation and analysis plan. All authors contributed to the development of the intervention and evaluation. YLi wrote the first draft of the manuscript, and PZ, FJH, KS, BW, NW, GAM and CW revised the draft. All authors contributed to the refinement of the study protocol and approved the final manuscript.

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Competing interests FJH is an unpaid member of Action on Salt and World Action on Salt, Sugar and Health (WASSH). GAM is the unpaid chairman of Blood Pressure UK, and chairman of Action on Salt and Chairman of WASSH. Other authors declare no competing interests.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

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