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The effects of walkability on physical activity and obesity: a prospective observational study

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Abstract

Introduction

The prevalence of overweight and obesity is increasing worldwide, which could lead to a set of chronic and metabolic diseases. Physical activity is a modifiable factor for obesity, which was reported to be correlated with built environment. However, the effects of built environment on physical activity are controversial. Walkability is a convenient way to assess built environment. We aim to prospectively explore the relationship among walkability, physical activity, and obesity in Chinese participants in Chongqing, and provide evidence for future urban planning.

Methods and analysis

Participants will be recruited from people who receive health examinations in the Health Management Centre, the First Affiliated Hospital to Army Medical University. Exposures are workplace and residential addresses of the participants, which are transformed into Walkscore in the analysis. The primary outcomes are body mass index (BMI) calculated by the data collected at the date of health examination and daily steps during a 30-day follow-up period recorded by the WeChat mini application. Other health examination data of the participants will also be collected. Multivariate regression analysis will be performed to examine the relationship between exposures and outcomes.

Ethics and dissemination

The Protocol is approved by the Ethics Committee of the First Affiliated Hospital to Army Medical University (KY201839). The results will be actively disseminated through peer-review journals and conference publications.

Strengths and limitations of this study

This study is the first one to evaluate the effects of walkability on health in China as far as we know. It innovatively evaluates the effects of walkability on physical activity and obesity in a hilly city, which has potentials to unveil the unique feature of walkability in a hilly environment.

The daily steps will be recorded by WeChat mini application on participants' smartphones, which will indicate the daily activity of participants. However, the application would fail to record data during swimming and other physical activities during which the participants do not carry their phones.

The Walkscore could reflect the general situation of walkability in participants' address; however, it is unable to reveal the details in built environment.

Introduction

The prevalence of overweight and obesity has doubled worldwide since 1980, which is currently 5% in children and 12% in adults.[1] In 2015, the number of children and adults who suffered from obesity was 107.7 million and 603.7 million, respectively.[2] High body mass index (BMI), an indicator for obesity, was identified to be a risk factor for various chronic diseases, including cardiovascular disease, diabetes, chronic kidney disease, and cancers.[2] It is reported that Chinese overweight and obesity prevalence is 21.8% in 2007 and obesity rate in Chongqing is 10.3%.[3], [4]

One of the modifiable risk factors of obesity and chronic diseases is physical inactivity.[5], [6] Physical inactivity is partly due to insufficient activity during leisure time and an increase in sedentary behavior during occupational and domestic activities.[7] Additionally, an increase in the use of "passive" modes of transport has also been associated with declining physical activity levels, which means less walking in daily life.[7] Insufficient physical activity contributes to 6% of the disease burden of coronary heart disease, 7% of that of type 2 diabetes, 10% of that of breast cancer, and 10% of that of colon cancer.[8] As reported, more than 533,000 deaths and more than 1.3 million deaths could be averted annually by reducing the prevalence of physical inactivity by 10% and 25%, respectively.[8] Thus, in order to ameliorate physical inactivity, it is crucial to understand its associated factors and determinants. The factors associated with physical activity in high-income countries were reported to be age, sex, health status, self-efficacy, genetic factors, and motivation.[9] At the level of population, the factors outside health sectors have been identified to be causally related to physical inactivity, for example, urban planning, transportation system, and built environment.[9-11]

Walkability offers an alternative to assess the built environment, which is a key step in evaluating the effects of the built environment on physical activity.[12] However, there were disputes on these studies. A study published in Nature in 2017 with more than 700 thousand participants and 68 million days recorded revealed that higher walkability was associated with more daily steps, whose effect is stronger for females.[12] Porter and colleagues also indicated in a cohort study with 688 participants that as one aspect of the neighborhood environment, walkability is associated with physical activity among pregnant women.[13] Other studies from Japan and North America also supported the positive effects of built environment on physical activity.[14-16] However, a cohort study with 1819 households investigating moving to the former Olympic athletes' village in London discovered no effect associated with this living environment change on daily steps, indicating that ameliorating the built environment might be insufficient to enhance physical activity.[17] A study with 161 older adult participants in Canada also showed that walkability was not associated with physical activity volume or intensity.[18]In addition to these controversial evidences, there is no research of walkability effects on physical activity and health in China.

The factors of walkability usually include residential housing units, retail shops, public transportation, street-level movement density, the distance to behavior-related destinations.[19] Some studies also take into account the population density, the street connectivity, land-use diversity, infrastructure and safety for walking, aesthetics, and crime influence.[20-22] Walkscore

(www.walkscore.com) is a user-friendly open composite walkability index.It could evaluate the walkability of a mail address or a city and is widely used in the studies investigating the relationship between walkability and health status.[12], [23]

The evaluation of the walkability of a community and its effects on physical activity and health status of the residents in China could shed a light on urban design, laying a foundation for future urban planning policy and physical activity promotion interventions. In addition, there is a gap of research on the influences of walkability on the physical activity in a hilly city. This protocol is an observational, prospective cohort study of participants who receive physical examination in the First Affiliated Hospital to Army Medical University. The aim is to use Walkscore to evaluate the walkability of participants' residential and workplace addresses in Chongqing, a Chinese city, which is characterized by hilly topology and multi-commercial centres, and to analyze the relationships of walkability and physical activity with overweight, obesity, and physical signs such as blood glucose, lipids, and so on.

Materials and Methods

Study design and setting

Blood samples, clinical data, and addresses are collected prospectively from participants who receive physical examination in the Health Management Centre, First Affiliated Hospital to Army Medical University. Clinical and demographic data are recorded in the hospital's database. The daily walking steps and the home and workplace addresses of participants are collected by WeChat mini application. Blood samples are examined by the clinical laboratory of the hospital. Participants will be recruited from October 2019 to 2020 and followed up till 2023. The recruitment period will be extended if necessary. The recruitment process can be referred to Figure 1.

Participants

This is an open cohort study. Participants are eligible for inclusion if they satisfy the following criteria: an age between 16 and 65, using smart phones, habitual residents in the downtown area of Chongqing.

The exclusion criteria will be: 1. participants with the symptoms or signs of cardiovascular and cerebrovascular diseases, such as chest tightness, shortness of breath, and even chest pain, especially those whose symptoms get worse when climbing stairs or walking fast; 2. participants with diagnosed heart diseases, such as coronary heart diseases, hypertensive heart diseases, valvular heart diseases, and pulmonary heart diseases, who need to exercise based on principles of cardiac rehabilitation; 3. participants with other severe complications of diabetes, such as those with vision severely affected by eye diseases, those with balancing ability affected by peripheral neuropathy, those with diabetic foot, and those with renal dysfunction; 4. participants

whose movement is affected by musculoskeletal disorders, e.g.patients with musculoskeletal disorders and cardiopulmonary dysfunction; 5.participantswho refuse to provide real and accurate information, or are not able to complete the questionnaire and physical examination; 6.participants who plan to migrate to other areas or leave for a long time (more than one year); 7.participants with secondary morbid obesity caused by congenital diseases, metabolic diseases, neurologic diseases and endocrine diseases. Participant inclusion and follow-up will be checked by the health managers and nurses in the Health Management Centre. Participants must be able to sign written informed consent after acknowledging the benefits and risks of this study.

The number of the sample size was calculated using the following formula:

$$n = \frac{\left(z_{\alpha}\sqrt{2\overline{pq}} + z_{\beta}\sqrt{p_0 q_0 + p_1 q_1}\right)^2}{\left(p_1 - p_0\right)^2}$$

The parameters used in the calculation are： P_0 (the obesity prevalence in control group)as 10.3%,[4] the supposed risk ratio (RR) between groups with high Walkscore and low Walkscore as 0.5, α =0.05， and 1- β =0.9. In this formula, $p_1=p_0*RR=5.15\%$, $\overline{p}= (p_0+p_1)/2$,$\overline{q}= 1-\overline{p}$, $q_0 = 1-p_0$, and $q_1 = 1 – p_1$, $Z_{\alpha} = 1.96$, and $Z_{\beta} = 1.282$. Based on these parameters, the sample size in exposure group and control group should be 400, respectively. Concerning the possibility of loss of follow-up, we increased the sample size by 10% to 440 participants in each group. The final sample size is 880 in total.

Clinical data

During the process of inclusion, the following data were collected by the health managers and nurses:

1. Participant demographics: age, gender, height, marital status, and education.
2. Exposure: workplace address and residential address of the participants.
3. Lifestyle factors: smoking status, alcohol consumption, online food order habit, and so on.
4. Primary outcome: Body mass index (BMI), and everyday walking steps are recorded by a WeChat mini application. Every year, the monthly daily steps will be collected after physical examination in the hospital. BMI was calculated by the weight in kilograms divided by the square of the height in meters. Overweight and obesity were defined as a BMI of 24–27.9 kg/m^2 and a BMI ≥ 28 kg/m^2, respectively[24]. The participants will authorize the researchers in this study to obtain the daily steps in 30 days collected by the WeChat mini application.
5. Secondary outcomes: metabolic profiles by blood tests; for example, cholesterol levels and blood glucose. Body composition was measured by a machine named inbody 220.
6. Identification of non-communicable diseases: e.g. hypertension, coronary artery disease, and diabetes.

Biological samples

The participants should be fasting for 12 to 14 hours before examination. The blood samples are collected by nurses in health management Centre in the morning. A sum of 5mL blood was collected in the yellow tube with inert separating gel for cholesterol and glucose testing. A total of 2mL blood for blood routine test was stored in a purple tube with ethylenediaminetetraacetic acid (EDTA) as anticoagulant.

Assay methods

The blood samples are analyzed by automated biochemical analyzer, with the series number of Beckman AU5811. Total cholesterol was tested by the cholesteroloxidase (CHO) enzyme method. Triglyceride was tested by the glycerol phosphate dehydrogenase and peroxidase (GPO-POD) method.

Physical examination

The physical examination included the measurement of height, body weight, blood pressure, and body component following the guidelines of the Health Management Centre. The blood pressure was evaluated by electronic sphygmomanometer (Omron, type： B-203RV III C). The body composition was assessed by a machine named inbody 220.

Statistical methods

Descriptive statistics is performed to analyze the distribution of the data. Missing data was addressed by deletion or last observation carried forward based on specific case status. Single variable analysis will be implemented to analyze the correlations between exposures, lifestyle factors (potential confounders), and outcomes. The participants will be divided into four groups by the quartiles of the Walkscore with regard of workplace address and residential address, respectively (In this way, we decide the exposure degree). The lifestyle factors and outcomes will be compared among groups. Multivariate linear regression will be conducted taken BMI and daily steps as dependent variables, respectively. Sensitivity analysis will be implemented by leave-one-out method.

Ethics and dissemination

The Protocol is approved by the Ethics Committee of the First Affiliated Hospital to Army Medical University (KY201839). All the participants will receive consultation about the benefits and possible risks of the study from health managers and nurses, and endow written informed consent before enrollment. All the participants will be informed that they can withdraw from the study at any time for any reason. The withdrawal cases will be discarded and related information will be deleted from the database of the study.

The sample volume of blood for the study is 11 per participant-visit and maximum 55 for five

years. The blood sampling process is part of procedure of physical examination and this study acquires the data use authority after the recruitment. The participants will be contacted and informed the results of the physical examination. The researchers of this study will be responsible for implementing the study adhering to the Declaration of Helsinki.

We plan to analyze and publish study results according to the STROBE guidelines. Results will be published in international and peer-reviewed scientific journals. Negative, positive or inconclusive results will be published.

Study Status

Participant recruitment will start in October 2019 and is expected to continue until 2020, with follow-up until 2023. The follow-up will be sustained by contacting with participants and requiring body examination by phone. Currently, the daily steps collector of the WeChat mini application is under development. The study was registered in Chinese Clinical Trial Registry (ChiCTR) and the registration number is ChiCTR1800017680.

Discussion and potential limitations

This observational and prospective study could innovatively provide evidence of the relationship among walkability, obesity, and physical activity in China. It will also provide evidence of the influence of built environment on physical activity in a hilly city, Chongqing. We hypothesized that the walkability, physical activity, and obesity status are strongly associated with each other.

There are some limitations in the collection of physical activity. The WeChat mini application can only record the daily steps when the participants walk with their phone. Like other studies, activities without carrying phones such as swimming and ball games will not be recorded in the data collection procedure.[12] Moreover, more than 30 days' collection needs second authorization which is less adherent; thus the researchers could only collect the data of 30 days for convenience. In order to compensate for this limitation, the participants will be recruited all year round and the researchers will ask for a second authorization of daily step collection in the follow-up visit.

Moreover, Walkscore is based on an online calculation website which has not opened the algorithm. Other walkability evaluation tools such as Neighborhood Environment Walkability Scale (NEWS) and Pedestrian Environment Quality Index (PEQI) depend on the evaluation of geographic information system (GIS), the score process of which is relatively clean; however, the practice is more complex.[25-27] Thus, we decide to choose Walkscore for the primary analysis. If the results could indicate the relationship between walkability and obesity, we could further analyze the component factors of walkability in following analysis.

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Competing interests: All authors have completed the ICMJE uniform disclosure form at http://www.icmje.org/coi_disclosure.pdf and declare: no support from any organization for the submitted work; no financial relationships with any organization that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work.

Contributors: SC and YZ are joint first authors. SC contributed to study concept. SC wrote the first draft of the protocol manuscript. ZC supervised the process. YZ and JS revised the manuscript after feedback from all authors. All authors reviewed the manuscript and approved the final version of the manuscript.

Data sharing statement: No additional data are available.

Patient consent: Consent will be obtained in the enrollment process.

Ethics approval: The Protocol is approved by the Ethics Committee of the first affiliated hospital to Army Medical University (KY201839).

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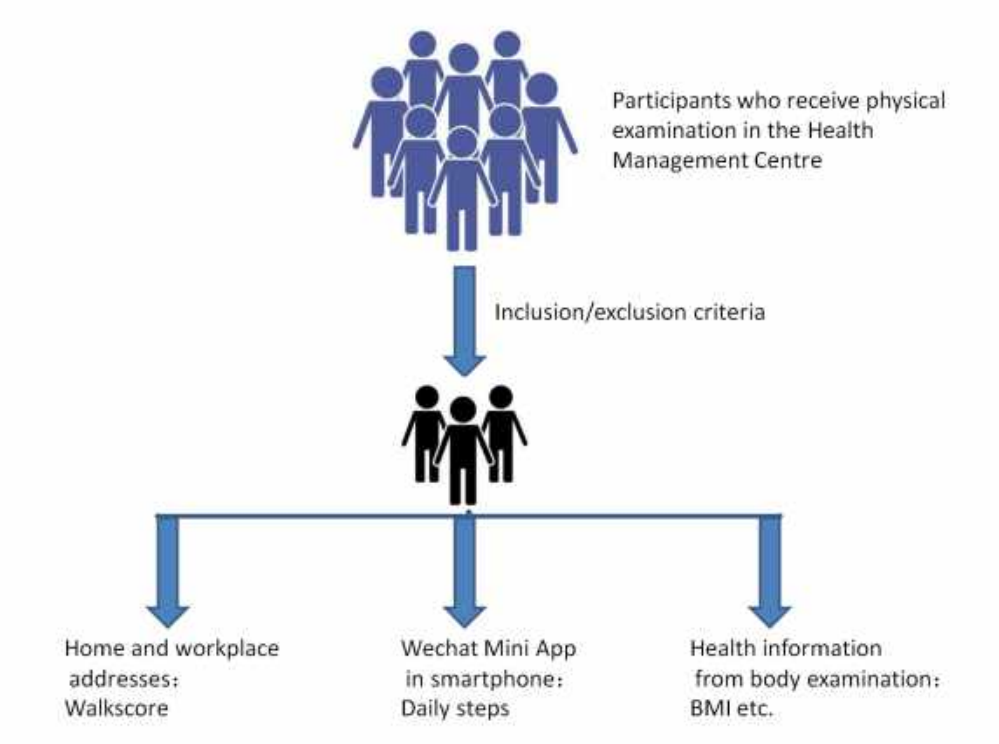

Figure 1. Flow chart

506x378mm (72 x 72 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract P2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found P2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported P3
Objectives	3	State specific objectives, including any prespecified hypotheses P3
Methods		
Study design	4	Present key elements of study design early in the paper P5-P6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection P4-P7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up P4-P5 *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed P6 *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable P4-P7
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 P6-P7
Bias	9	Describe any efforts to address potential sources of bias P6-P7
Study size	10	Explain how the study size was arrived at P6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why P7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding P7
		(*b*) Describe any methods used to examine subgroups and interactions P7
		(*c*) Explain how missing data were addressed P7
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed P7 *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses P6

Continued on next page

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
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount) P7
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
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
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias P7
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence P7
Generalisability	21	Discuss the generalisability (external validity) of the study results P7
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

*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.

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Ethics Committee of the First Affiliated Hospital
of Army Medical University, PLA

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批件号：KY201839

项目名称	城市可步行性对超重和肥胖影响的前瞻性队列研究
试验分类	□注册药物　□注册器械　■临床科研　□其他
临床分期	药物适用：□I 期　□II 期　□III 期　□IV 期　□其他： 器械适用：□临床试用　□临床验证　□其他：
申办单位	无
申请科室	健康管理科
主要研究者/职称	陈宗涛/副研究员
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The effects of walkability on physical activity and obesity: a prospective observational study protocol

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Abstract

Introduction

The prevalence of overweight and obesity is increasing worldwide, which could lead to a set of chronic and metabolic diseases. Physical activity is a modifiable factor for obesity, which was reported to be correlated with built environment. However, the effects of built environment on physical activity are not consistent. Walkability is a convenient way to assess built environment. We aim to prospectively explore the relationship among walkability, physical activity, and obesity in Chinese participants in Chongqing, and provide evidence for future urban planning.

Methods and analysis

Participants will be recruited from people who receive health examination in the Health Management Centre, the First Affiliated Hospital to Army Medical University. Exposures are workplace and residential addresses of the participants, which are transformed into WalkScore in the analysis. The primary outcomes are body mass index (BMI) calculated by the data collected at the date of health examination and daily walking steps during a 30-day follow-up period recorded by the WeChat mini application. Other health examination data of the participants will also be collected. Multivariate regression analysis will be performed to examine the relationship between exposures and outcomes.

Ethics and dissemination

The Protocol is approved by the Ethics Committee of the First Affiliated Hospital to Army Medical University (KY201839). The results will be actively disseminated through peer-review journals and conference publications.

Strengths and limitations of this study

- This study is the first one to evaluate the effects of walkability on health in China as far as we know. It innovatively evaluates the effects of walkability on physical activity and obesity in a hilly city, which has potentials to unveil the unique feature of walkability in a hilly environment.
- The daily walking steps will be recorded by WeChat mini application on participants' smartphones, which will indicate the daily activity of participants. However, the application would fail to record data during swimming and other physical activities during which the participants do not carry their phones.
- The WalkScore could reflect the general situation of walkability in participants' address; however, it is unable to reveal the details in built environment.

Introduction

The prevalence of overweight and obesity has doubled worldwide since 1980, which is currently 5% in children and 12% in adults. [1] In 2015, the number of children and adults who suffered from obesity was 107.7 million and 603.7 million, respectively.[2] High body mass index (BMI), an indicator for obesity, was identified to be a risk factor for various chronic diseases, including cardiovascular disease, diabetes, chronic kidney disease, and cancers.[2] China Health and Nutrition Survey showed the rate of obesity and overweight in adults increased from 25.1% to 39.6% from 1997 to 2009.[3] The updated prevalence of overweight and obesity were reported to be 25.8% and 7.9%, respectively, in 2017.[4] It is reported that the obesity rate in Chongqing in Southwestern China is 10.3%.[5], [6]

One of the modifiable risk factors of obesity and chronic diseases is physical inactivity.[7], [8] Physical inactivity is partly due to insufficient activity during leisure time and an increase in sedentary behavior during occupational and domestic activities.[9] Additionally, an increase in the use of "passive" modes of transport has also been associated with declining physical activity levels, which means less walking or any human powered movement in daily life.[9] Insufficient physical activity contributes to 6% of the disease burden of coronary heart disease, 7% of that of type 2 diabetes, 10% of that of breast cancer, and 10% of that of colon cancer.[10] As reported, more than 533,000 deaths and more than 1.3 million deaths could be averted annually by reducing the prevalence of physical inactivity by 10% and 25%, respectively.[10] Thus, in order to ameliorate physical inactivity, it is crucial to understand its associated factors and determinants. The factors associated with physical activity in high-income countries were reported to be age, sex, health status, self-efficacy, genetic factors, and motivation.[11] At the level of population, the factors outside health sectors have been identified to be causally related to physical inactivity, for example, urban planning, transportation system, and built environment.[11-13]

Walkability is a key step in evaluating the effects of the built environment on physical activity.[14] However, there have been inconsistence with respect to built environment, walkability, physical activity, and health. A study published in *Nature* in 2017 with more than 700 thousand participants and 68 million days recorded revealed that higher walkability was associated with more daily walking steps, whose effect was stronger for females.[14] Porter and colleagues also indicated in a cohort study with 688 participants that as one aspect of the neighborhood environment, walkability was associated with physical activity among pregnant women.[15] Other studies from Japan and North America also supported the positive effects of built environment on physical activity.[16-18] In a middle size city Bengbu in Eastern China, researchers observed about at least 30% lower risk of cardiovascular diseases were associated with moderate to high levels of WalkScore, compared with controls with low WalkScore.[19] However, a cohort study with 1819 households investigating moving to the former Olympic athletes' village in London discovered no effect associated with this living environment change on daily walking steps, indicating that ameliorating the built environment might be insufficient to enhance physical activity.[20] A study with 161 older adult participants in Canada also showed that walkability was not associated with physical activity volume or intensity.[21] A study in a small city in China called Yuncheng also showed no positive associations of land-use mix and walking

duration.[22] In addition to these consistent evidence, there is no research of walkability effects on physical activity and health in China.

The factors of walkability usually include residential housing units, retail shops, public transportation, street-level movement density, the distance to behavior-related destinations.[23] Residential housing units are a house, apartment, group of rooms, or a single room for occupancy as a separate living unit, which could predict the population allocation in an area.[24] Retail shops are one kind of points of interest, which serve for non-residential uses and can enhance the motivation of walking.[25] Well-connected streets, which are represented by the street-level movement density and the distance to behavior-related destinations, as well as the proximate access to public transportation are crucial characteristics of a walkable neighborhood.[26] Some studies also take into account the population density, the street connectivity, land-use diversity, infrastructure and safety for walking, aesthetics, and crime influence.[27-29] WalkScore (www.WalkScore.com) is a user-friendly open composite walkability index. It could evaluate the walkability of a mail address or a city and is widely used in the studies investigating the relationship between walkability and health status.[14, 30]

The evaluation of the walkability of a community and its effects on physical activity and health status of the residents in China could shed a light on urban design, laying a foundation for future urban planning policy and physical activity promotion interventions. Additionally, there is a gap of research on the influences of walkability on the physical activity in a hilly city. This protocol is an observational, prospective cohort study of participants who receive physical examination in the First Affiliated Hospital to Army Medical University. The location of our protocol is Chongqing, a Chinese city, with multi-commercial centres, which is characterized by a unique hilly topology with two rivers, Yangtze and Jialing. The aim is to analyze the relationships among walkability, physical activity, and obesity in the residents in Chongqing for future urban planning reference. A map and a photo with the hilly topography of Chongqing are showed in Supplementary Figure 1.

Materials and Methods

Study design and setting

Blood samples, clinical data, addresses, and related variables are collected prospectively from participants who receive physical examination in the Health Management Centre, First Affiliated Hospital to Army Medical University. Clinical and demographic data are recorded in the hospital's database. The daily walking steps of participants are collected by WeChat mini application. Blood samples are examined by the clinical laboratory of the hospital. The addresses and the part of listed variables in Table 1 will be collected by questionnaire. Participants will be recruited from October 2019 to 2020 and followed up till 2023. The recruitment period will be extended if necessary. Moreover, we will include the participants who had pre-existing appointment if he/she meets the inclusion/exclusion criteria. We need to require this kind of participants to provide home and workplace addresses on the first visit and fill questionnaire on the second visit after recruitment. The recruitment process can be referred to Figure 1.

Table 1. All measured variables.

Variable category	Name of variable	Normal limits or categories	Definition of variables	Sources of data
Primary Outcomes	Body mass index	18.5-24kg/m2	Outcome	Calculate from health examination data
	Daily walking steps in one month		Outcome and mediator	Wechat mini application
Secondary Outcomes	Fasting blood glucose (GLU)	3.6-6.1 (mmol/L)	Outcome	Health examination
	Total cholesterol (TC)	3.1-5.7 (mmol/L)	Outcome	Health examination
	Triglyceride (Tg)	0.4-1.73 (mmol/L)	Outcome	Health examination
	Low density lipoprotein cholesterin (LDL-C)	2.07-3.1 (mmol/L)	Outcome	Health examination
	High density lipoprotein cholesterin (HDL-C)	0.9-2 (mmol/L)	Outcome	Health examination
	Body composition	Mass percentage of fat	Outcome	Health examination
Other variables	Height			Health examination
	Weight			Health examination
	Age	16 - 65 years old	Possible confounding	Questionnaire
	Gender	Male；female	Possible confounding	Questionnaire
	Job		Possible confounding	Questionnaire
	Education	Under primary school; primary school, middle school; bachelor; master and above	Possible confounding	Questionnaire
	WalkScore corresponding	0-100	Exposure	Calculate from questionnaire

	to home address			information
	WalkScore corresponding to workplace addres	0-100	Exposure	Calculate from questionnaire information
	Smoking status	Giving up; never; sometimes smoke; frequently smoke	Other factors will influence outcome	Questionnaire
	Alcohol consumption	Giving up; never; sometimes drink; frequently drink	Other factors will influence outcome	Questionnaire
	Online food order habit	Never; sometimes order; frequently order	Possible confounding	Questionnaire
	Eating diet	More details showed in questionnaire	Other factors will influence outcome	Questionnaire
	Physical activity	More details showed in questionnaire	Possible confounding	Questionnaire

Participants

This is an open cohort study. Participants are eligible for inclusion if they satisfy the following criteria: an age between 16 and 65, using smart phones, habitual residents in the downtown area of Chongqing.

The exclusion criteria will be: 1. participants with the symptoms or signs of cardiovascular and cerebrovascular diseases, such as chest tightness, shortness of breath, and even chest pain, especially those whose symptoms get worse when climbing stairs or walking fast; 2. participants with diagnosed heart diseases, such as coronary heart diseases, hypertensive heart diseases, valvular heart diseases, and pulmonary heart diseases, who need to exercise based on principles of cardiac rehabilitation; 3. participants with other severe complications of diabetes, such as those with vision severely affected by eye diseases, those with balancing ability affected by peripheral neuropathy, those with diabetic foot, and those with renal dysfunction; 4. participants whose movement is affected by musculoskeletal disorders, e.g. patients with musculoskeletal disorders and cardiopulmonary dysfunction; 5.participants who refuse to provide real and accurate information, or are not able to complete the questionnaire and health examination; 6.participants who plan to migrate to other areas or leave for a long time (more than one year); 7.participants with secondary morbid obesity caused by congenital diseases, metabolic diseases, neurologic diseases and endocrine diseases. Participant inclusion and follow-up will be checked by the health managers and nurses in the Health Management Centre. Participants must be able to sign written informed consent after acknowledging the benefits and risks of this study.

The number of the sample size was calculated using the following formula:

$$n = \frac{\left(z_{\alpha}\sqrt{2\overline{pq}} + z_{\beta}\sqrt{p_0 q_0 + p_1 q_1}\right)^2}{\left(p_1 - p_0\right)^2}$$

The parameters used in the calculation are： P_0 (the obesity prevalence in control group) as 10.3%,[6] the supposed risk ratio (RR) between groups with high WalkScore and low WalkScore as 0.5, $\alpha = 0.05$， and $1-\beta = 0.9$. In this formula, $p_1 = p_0 * RR = 5.15\%$, $\bar{p} = (p_0+p_1)/2$, $\bar{q} = 1-\bar{p}$, $q_0 = 1-p_0$, and $q_1 = 1 - p_1$, $Z_{\alpha} = 1.96$, and $Z_{\beta} = 1.282$. Based on these parameters, the sample size in exposure group and control group should be 400, respectively. Concerning the possibility of loss of follow-up, we increased the sample size by 10% to 440 participants in each group. The final sample size is 880 in total.

Clinical data

During the process of inclusion, the following data were collected by the questionnaire and health examination procedure as well as Wechat mini application:

1. Participant demographics: age, gender, height, marital status, and education.

2. Exposure: workplace address and residential address of the participants.
3. Lifestyle factors: smoking status, alcohol consumption, online food order habit, eating diet, and physical activity
4. Primary outcomes: Body mass index (BMI), and everyday walking steps are recorded by a WeChat mini application. Every year, the monthly daily walking steps will be collected after physical examination in the hospital. BMI was calculated by the weight in kilograms divided by the square of the height in meters. Overweight and obesity were defined as a BMI of 24–27.9 kg/m^2 and a BMI ≥ 28 kg/m^2, respectively.[4] The participants will authorize the researchers in this study to obtain the daily walking steps in 30 days collected by the WeChat mini application.
5. Secondary outcomes: metabolic profiles by blood tests; for example, cholesterol levels and blood glucose. Body composition was measured by a machine named inbody 220.
6. Identification of non-communicable diseases: e.g. hypertension, coronary artery disease, and diabetes.

The questionnaire filled by participants under nurses' guidance includes the questions of participant demographics, exposure, lifestyle factors. We attached the full version of the questionnaire in Supplementary File 1. The measured variables, primary outcome, and secondary outcomes as well as possible confoundings are listed in Table 1. The variables in detail are showed in Supplementary File 2. The relationships among different variables are illustrated in a causal diagram in Supplementary Figure 2.

Biological samples

The participants should be fasting for 12 to 14 hours before health examination. The blood samples are collected by nurses in the Health Management Centre in the morning. A sum of 5mL blood was collected in the yellow tube with inert separating gel for cholesterol and glucose testing. A total of 2mL blood for blood routine test was stored in a purple tube with ethylenediaminetetraacetic acid (EDTA) as anticoagulant.

Assay methods

The blood samples are analyzed by automated biochemical analyzer, with the series number of Beckman AU5811. Total cholesterol was tested by the cholesteroloxidase (CHO) enzyme method. Triglyceride was tested by the glycerol phosphate dehydrogenase and peroxidase (GPO-POD) method.

Physical examination

The physical examination included the measurement of height, body weight, blood pressure, and body component following the guidelines of the Health Management Centre. The blood pressure was evaluated by electronic sphygmomanometer (Omron, type： B-203RV III C). The body composition was assessed by a machine named inbody 220.

WalkScore

WalkScore measures pedestrian friendliness by analyzing the distance to point of interest, population density, block length, and intersection density. Data sources are from Google, Factual, Great Schools, Open Street Map, the U.S. Census, Localeze, and places added by the Walk Score user community.[31] The algorithm of WalkScore is not disclosed in its official website. The formula[32] of WalkScore illustrated in Tsinghua University is

$$\sum_{i=1,j=1}^{m,n}(W_i * S_{i,j} * D_{i,j}) * \frac{100}{15} .$$

W_i is the weight of one kind of amenity. Table 2 shows the weights of different amenities.

Amenity category	Weight	Amenity category	Weight	Amenity category	Weight
convenience store	3	café/teahouse	2	school	1
restaurant	3	bank	1	bookstore	1
shop	2	park	1	entertainment places	1

Table 2. Weights of different amenities.

The letter of i stands for different kinds of amenities. The letter of j stands for different walking distance. $S_{i,j}$ stands for service scope of a specific amenity. $D_{i,j}$ stands for the attenuation coefficient based on distance from the calculated point to an amenity. Table 3 shows the attenuation coefficients based on the distances from the calculated point to an amenity.

Distances	Attenuation coefficients
<400 metres	1
400-800 metres	0.9
800-1200 metres	0.55
1200-1600 metres	0.25
1600-2400 metres	0.08
>2400 metres	Out of scope, which will not be calculated.

Table 3. Attenuation coefficients based on the distances.

The calculation of WalkScore is free, to obtain which we could type the name of calculated point into the official website and wait for the score. The limit of the score is 0-100. The WalkScore of residential address and workplace address will be calculated separately.

The following Table 4 describes the meanings of different WalkScore.

WalkScore	Description
90 - 100	Walker's Paradise: Daily errands do not require a car.
70 - 89	Very Walkable: Most errands can be accomplished on foot.
50 - 69	Somewhat Walkable: Some errands can be accomplished on foot.

25 - 49	Car-dependent: Most errands require a car.
0 - 24	Almost all errands require a car.

Table 4. Interpretations of different WalkScore.

Wechat mini application

Wechat is a cellphone application for communication used by more than a billion people.[33] The customers of it can send voice, video, photos, and text. On the basis of Wechat and its great number of users, the company of Wechat opens the resources to the public of developing different kinds of Wechat mini applications. Users could link its Wechat ID to Wechat mini application without download installment package and achieve data sharing through Wechat mini application. Through Wechat mini application, we could extract the daily walking steps of Wechat users in one month after customer agreement.

Statistical methods

The data analysis will be conducted after data collection in 2020. The prospective analysis will be implemented in 2023. Descriptive statistics is performed to analyze the distribution of the data. Missing data were addressed by deletion or last observation carried forward based on specific case status. Single variable analysis will be implemented to analyze the correlations between exposures, possible confoundings (i.e., online food order habit, education, job, physical activity), and outcomes. The participants will be divided into five groups by the categories of the WalkScore with regard to workplace address and residential address, respectively (In this way, we decide the exposure degree). The lifestyle factors and outcomes will be compared among groups. All the variables in causal diagrams will be compared between baseline and follow-ups. T-test will be used for the continuous variables, and Chi-square test or Analysis of Variance (ANNOVA) will be used for categorized variables. Multivariate linear regression will be conducted taken BMI and daily walking steps as dependent variables, respectively, as cross-sectional analyses, after data collection in 2020. Further longitudinal analyses with G estimation and inverse probability weight analysis will be conducted after data collection in 2023. Sensitivity analysis will be implemented by bootstrap method. With replacement from the original dataset, the bootstrap method enables estimation of the accuracy of an estimator by random sampling. The first step is to determine the ranges and variations of the independent variables, which are input into our multivariate linear regression. The second step is to generate independent variables based on the Sobol sequence by R package ‘‘randtoolbox’’. The final step is to collect and process the simulation results, which can be used in sensitivity analysis through conducting multivariate linear regression.[34]

Patient and public involvement

Our study is an observational study without intervention on participants. The development of the research question and outcome measures were informed by participants’ priorities,

experience, and preferences on the basis of informed consents. There is no participants' involvement in the study design. We recruit participants when conducting the study, but participants would not be the conductor of the study. The results are planned to disseminate to study participants.

Ethics and dissemination

The Protocol is approved by the Ethics Committee of the First Affiliated Hospital to Army Medical University (KY201839). All the participants will receive consultation about the benefits and possible risks of the study from health managers and nurses, and endow written informed consent before enrollment. All the participants will be informed that they can withdraw from the study at any time for any reason. The withdrawal cases will be discarded and related information will be deleted from the database of the study.

The sample volume of blood for the study is 11 per participant-visit and maximum 55 for five years. The blood sampling process is part of the procedure of physical examination and this study acquires the data use authority after the recruitment. The participants will be contacted and informed the results of the physical examination. The researchers of this study will be responsible for implementing the study adhering to the Declaration of Helsinki.

We plan to analyze and publish study results according to the STROBE guidelines. Results will be published in international and peer-reviewed scientific journals. Negative, positive or inconclusive results will be published.

Study Status

We collected demographic data, home addresses, and workplace addresses of participants in October 2019. We plan to check previous data and collect the data of health examination and questionnaire of participants in March to May 2020 and daily walking steps of participants by Wechat mini application in 2020 (in one month after health examination). We will continue follow-up in 2021-2023. The follow-up will be sustained by contacting with participants and requiring body examination by phone. Currently, the daily walking steps collector of the WeChat mini application has been developed. The study was registered in Chinese Clinical Trial Registry (ChiCTR) and the registration number is ChiCTR1800017680. The date of the study in a timeline is showed in Supplementary Table 1. There will be six waves of date collection.

Discussion and potential limitations

This observational and prospective study could innovatively provide evidence of the relationship among walkability, obesity, and physical activity in China. It will also provide evidence of the influence of built environment on physical activity in a hilly city, Chongqing. We hypothesized that the walkability, physical activity, and obesity status are strongly associated with each other. Our research hypothesis is that high WalkScore will be associated with the decrease of BMI. The

daily walking steps and metabolic profiles will be the mediators through the effect pathway from WalkScore to BMI. We illustrate our hypothesis of causal diagram in Supplementary Figure 2.

There are some limitations in the collection of physical activity. The WeChat mini application can only record the daily walking steps when the participants walk with their phone. Like other studies, activities without carrying phones such as swimming and ball games will not be recorded in the data collection procedure.[14] Moreover, more than 30 days' collection needs second authorization which is less adherent; thus the researchers could only collect the data of 30 days for convenience. In order to compensate for this limitation, the participants will be recruited all year round and the researchers will ask for a second authorization of daily step collection in the follow-up visit.

Moreover, WalkScore is based on an online calculation website which has not opened the algorithm officially. Other walkability evaluation tools such as Neighborhood Environment Walkability Scale (NEWS) and Pedestrian Environment Quality Index (PEQI) depend on the evaluation of geographic information system (GIS), the score process of which is relatively clean; however, the practice is more complex.[35-37] Thus, we decide to choose WalkScore for the primary analysis. If the results could indicate the relationship between walkability and obesity, we could further analyze the component factors of walkability in following analysis.

Legends

Figure 1. Flow chart of study.

Supplementary Figure 1A. Chongqing map.
It is the nine main districts of Chongqing extracted from Google map. The black point shows the location of the First Affiliated Hospital to Army Medical Univerisity in Shapingba District. Shapingba District is an old town with a lot of renowned high schools and universities.

Supplementary Figure 2B. Chongqing streetscape 1.
It is the streetscape in Egongyan Bridge, which shows the multi-dimensioned streets and transportation ways of the city. Photographed by Yirui Gong.

Supplementary Figure 2. Causal diagram of measured variables.
Obesity and overweight is the primary outcome. WalkScore is the exposure variable. Daily walking steps and metabolic profiles are the mediator from WalkScore to obesity. Job and education are possible confoundings between WalkScore and daily walking steps. Physical activity and mental health scores are possible confoundings between daily walking steps and metabolic profiles. Online food order habit is possible confounding between WalkScore and metabolic profiles. Eating habit, smoking, and alcohol consumption are other factors, which will

influence metabolic profiles.

Supplementary Table 1. Timeline of study conduction.

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Competing interests: All authors have completed the ICMJE uniform disclosure form at http://www.icmje.org/coi_disclosure.pdf and declare: no support from any organization for the submitted work; no financial relationships with any organization that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work.

Contributors: SC and YZ are joint first authors. SC contributed to study concept and design. SC wrote the first draft of the protocol manuscript. ZC supervised the process. YZ and JS revised the manuscript after feedback from all authors. YZ coordinates the conducting of this study. All authors reviewed the manuscript and approved the final version of the manuscript.

Data sharing statement: No additional data are available.

Patient consent: Consent will be obtained in the enrollment process.

Ethics approval: The Protocol is approved by the Ethics Committee of the first affiliated hospital to Army Medical University (KY201839).

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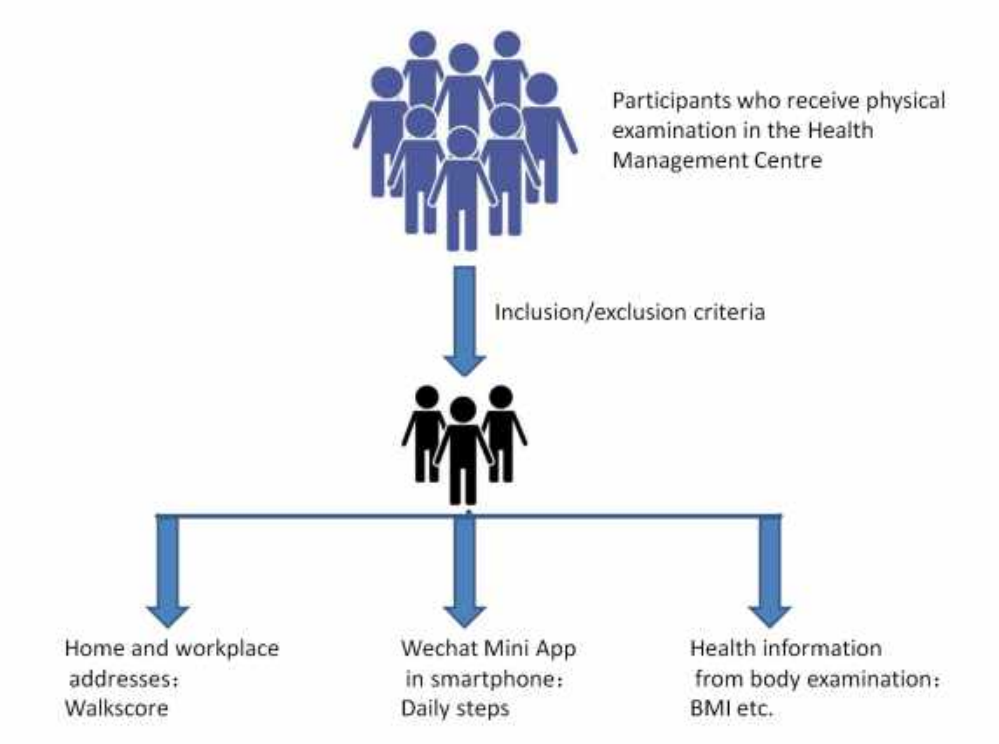
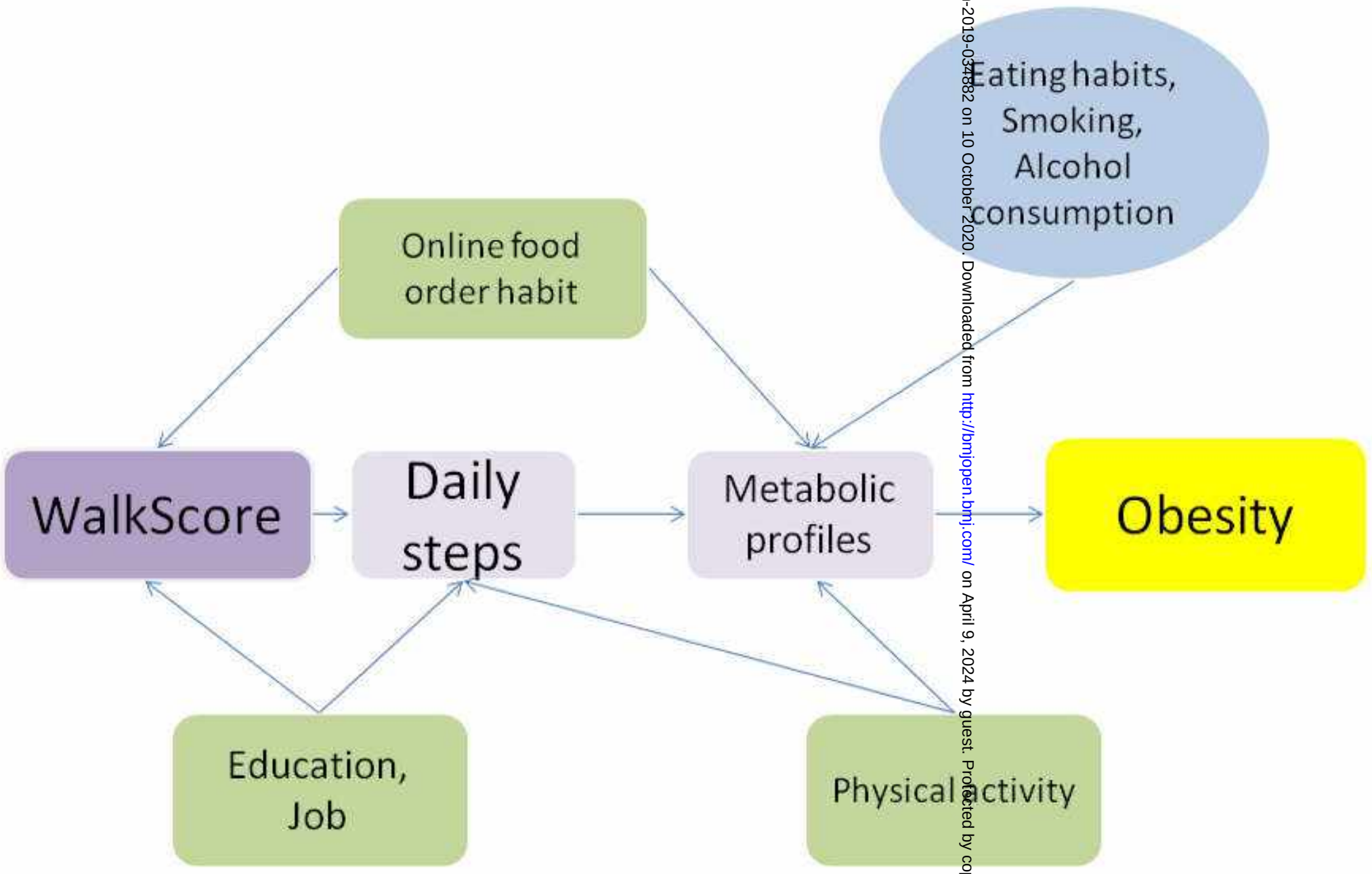


Figure 1. Flow chart

506x378mm (72 x 72 DPI)



Questionnaire

Part One: Basic Personal Information

1. Name: _____

2. Physical Examination Number: _____

3. Birthplace: City_____, Province_____

4. Present Address: Number_____, Neighborhood Committee/Village_____, Township/Street_____, District/County_____, City_____ Province_____

5. Work Address: Number_____, Neighborhood Committee/Village_____, Township/Street_____, District/County_____, City_____ Province_____

6. Except for home and office, is there any other place you are frequently present?

☐Yes ☐No If yes, how long will you spend in this place in one week? ____hours

7. ID Number: _____

8. Nationality: ☐The Han Nationality ☐National Minority: _____

9. Blood Type: _____

10. Height: _____ cm

11. Weight: _____ kg

12. Education Level:

☐Did not attend school normally ☐Primary school or below

☐Junior high school ☐High school and secondary technical school

☐Junior college ☐Undergraduate college

☐Master degree and above

13. Category of Employment:

☐Company employee ☐House ☐Student

☐Active duty soldier ☐Freelancer ☐Industrial worker

☐Self-employed people ☐Full-time driver

☐Service and sales personnel ☐Professional and technical personnel

☐Civil servant, personnel of public institutions and state-owned enterprises

☐Farmers, herdsmen and fishermen ☐Others

14. Are you currently customer of Wechat daily step calculator?

☐Yes ☐No

15. In the past week, what is your average step recorded by Wechat daily step calculator, or other step recorder? _____steps

Part Two: Family History and Personal Health Status

1. Family History (Choose the diseases which your relatives are / were diagnosed with at present / in the past from those listed below)

Are / were your parents, brothers or sisters currently diagnosed with the following diseases?

(multiple choice, put a √ under the options)

Diseases	Father	Mother	Brother	Sister
Lung cancer				
Liver cancer				
Gastric cancer				
Esophageal cancer				
Colorectal cancer				
Thyroid cancer				
Prostate cancer				
Cervical cancer				
Endometrial cancer				
Ovarian cancer				
Breast cancer				
Diabetes mellitus				
Hypertension				
Obesity				
Gout (hyperuricemia)				
Hyperlipidemia				
Asthma				
Chronic obstructive pulmonary (chronic bronchitis, emphysema)				
Stroke				
Coronary heart disease or myocardial infarction				
Osteoporosis				
Mental disease				
Other diseases				
None				

2. Personal History of Diseases

Whether the following diseases are / were diagnosed? (multiple choice)

☐Lung cancer ☐Liver cancer ☐Gastric cancer ☐Esophageal cancer

☐Colorectal cancer ☐Thyroid cancer ☐Prostate cancer ☐Cervical cancer

☐Endometrial cancer ☐Ovarian cancer ☐Breast cancer ☐Diabetes

☐Hypertension ☐Hyperlipidemia ☐Stroke ☐Asthma

☐Osteoporosis ☐Fracture ☐Mental disorders ☐Neurasthenia

☐Gout (hyperuricemia) ☐Thyroid disease (thyroiditis, nodule)

☐Chronic cholecystitis and cholelithiasis ☐Gastritis or duodenal ulcer

☐Coronary heart disease or myocardial infarction

☐Prostatic disease (hyperplasia of prostate, hypertrophy)

☐Chronic obstructive pulmonary disease (chronic bronchitis, emphysema)

☐Chronic liver disease (☐hepatitis B, ☐hepatitis C, ☐fatty liver, ☐alcoholic liver, ☐liver cirrhosis)

☐Chronic glomerulonephritis (nephritis, nephrotic syndrome, chronic renal insufficiency)

☐Chronic breast diseases (hyperplasia of mammary glands, nodules, adenosis, cysts, etc.)

☐Chronic gynecologic diseases (uterine fibroids, ovarian cysts, inflammations, etc.)

☐History of operation: (The operation name:____)

☐Other diseases ☐None of the above diseases

3. Medication History

Do you take the following medicines for a long term? (continuous use for above 6 months, and more than once per day on average)

☐Hypotensive drugs ☐Beta blockers

☐Psychotropic drugs ☐Antiarrhythmic drugs

☐Uric acid-lowering drugs

☐Hypoglycemic drugs

☐Sedative or hypnotic drugs

☐Hormone drugs

☐Chinese herbal medicines

☐Antipyretic analgesics

☐Antiplatelet drugs such as aspirin

☐Lipid-modulating drugs (lipid-lowering drugs)

☐Angiotensin-converting enzyme inhibitors

☐Anti-asthmatic drugs

☐Others

☐None

Part Three: Eating Habits and Lifestyle

1. Eating Habit

1.1. Generally speaking, how many days during a week will you eat the following food on average? (single choice)

Rice	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Noodles	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Coarse Cereals	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Meat (pigs, cattle, sheep, poultry)	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Fish or other aquatic products	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Fresh vegetable and fruit	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Milk and dairy products	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Eggs and their products	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Beans and bean products	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Dessert (pastries, candy, etc)	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Fried food	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Pickled, smoked food	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat

1.2. In the past year, did you take the following nutrients for at least one month? (except for ginseng)

□Cod liver oil / fish oil □Ginseng (at least five times a year)

□Vitamin □Other health supplements

□Calcium / iron / zinc

1.3. Have you ever experienced severe food shortages in your life?

□Yes □No If not, please turn to question 4

1.3.1. In which year did you experience the most severe food shortage? _____

1.3.2. When you were experiencing the most severe food shortage:

1.3.2.1. Did your weight decrease significantly?

□Yes □ No If yes, it dropped by ___ kilograms

1.3.2.2. Did you suffer from edema, severe anemia and other diseases caused by food shortages such as? □Yes □ No

1.4. In the past month, how often did you eat spicy food?

□Never / almost never □1-2 days a week

□A few times, but less than once a week on average

□3-5 days a week □Every day or almost every day

1.5. How old did you begin to eat spicy food every week? ____ years old

1.6. Do you like slightly spicy food or very spicy food?

□Slightly spicy □Spicy □Very spicy

1.7. Do you order food online?

□Yes □No

1.8. How often will you order food online in one week? _____Times

1.9. What are the categories of online-ordered food you select?

□Noodles with soup □Rice □Fried noodles □Dumplings

□Sweet food, eg.cake □Drinks □Others

1.10. How often will you eat outside home (not including online order food)?
_____Times

2. Smoking

<table>
<tr><td rowspan="5">Do you smoke?
□Yes. Please answer questions 2.1, 2.2,2.5 and 2.6
□No. Please answer questions 2.7-2.8.
□Quit smoking. (have quit smoking for more than one month) Please answer questions 2.3-2.6.</td><td>2.1. You began to smoke at the age of _____.</td></tr>
<tr><td>2.2. You smoke ____ cigarettes per day on average.</td></tr>
<tr><td>2.3. You quitted smoking at the age of _____.</td></tr>
<tr><td>2.4. Before quitting smoking, you smoked _____ cigarettes per day on average.</td></tr>
<tr><td>2.5. Which type of cigarettes do you smoke at present/or did you smoke before quitting?
□Filter cigarette □Non-filter Cigarettes □Cigar
□Hand-rolled cigarette / tobacco
□Tobacco pipe / waterpipe smoking</td></tr>
<tr><td></td><td>2.6. Which organ do you suck the smoke into?</td></tr>
</table>

	□To the mouth and exhale it □To the pharynx and larynx □Deep to the lung-Have you kept the habit of sucking smoke into the lung ever since you began smoking? □Yes □No
	2.7. Have you ever been exposed to the second hand smoke? □Yes □No
	2.8. How many times have you been exposed to the second hand smoke? □Nearly everyday □4-5 days a week □1-3 days a week □＜1 day per week

3. Alcohol drinking

3.1. Do you drink alcohol? (Make the choice and fill in the blanks based on reality)

□Never □In the past (have quit drinking for more than 6 months)

□Yes (If yes, please answer questions 3.1.1-3.1.4)

3.1.1 You began to drink alcohol at the age of _____.

3.1.2 How often do you drink? (Single choice)

□Twice almost everyday □Once almost everyday □3-4 times a week

□1-2 times a week □Drink every month, but less than once a week □Seldom

3.1.3 How much do you drink each time (only fill in the blanks with the alcohol you drink commonly)?

□Beer, _____bottles/day

□Yellow wine / rice wine / fruit wine, _____grams/day

□Wine, ____grams/day

□Liquor with a high alcohol level (≥40°)，_____grams/day

□Liquor with a low alcohol level (≤40°)，_____grams/day

4. Sleeping (Make the choice and fill in the blanks based on reality)

4.1. How is the quality of your sleep in the past month?

□Very good □Good □Bad □Very bad

4.2. How long did you sleep per day on average in the past month? ___ hours

4.3. Did you need to take medicine to help you fall asleep in the past month? (medicine prescribed by the doctor or purchased by yourself)

□No □＜Once every week on average

□Once-twice every week on average □≥ 3 times every week on average

5. Physical activity

5.1. In the past year, what is your activity status during work?

□Sedentary □Standing □Activity with medium amount

□Activity with heavy work load □Retired or disabled to work

5.2. What is your average working hour in one week? _____hours

5.3. In the past your, what is your transportation way to go to work?

□Walking □Driving □Taking a bus

□Riding a bike □Work at home or the place closed to home □Others

5.4. How long is the commuting time of your work? _____min

5.5. In the past one year, what is your physical activity frequency?

□Never □1-3 times one month □1-2 times one week

□3 -5 times one week □Almost everyday

5.6. What is the exercise way you did the most frequently?

□Taichi/Walking □Fast walking □Running/or other aerobics

□Swimming □Ball game □Others(such as hiking)

5.7. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, heavy construction, or climbing up stairs as part of your work?

_____ days per week

5.8. How much time did you usually spend on one of those days doing vigorous physical activities as part of your work?

_____ hours per day，_____ minutes per day

5.9. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads as part of your work? Please do not include walking.

_____ days per week

5.10. How much time did you usually spend on one of those days doing moderate physical activities as part of your work?

_____ hours per day，_____ minutes per day

5.11. During the last 7 days, on how many days did you walk for at least 10 minutes at a time as part of your work?

_____ days per week

5.12. How much time did you usually spend on one of those days walking as part of your work?

_____ hours per day，_____ minutes per day

5.13. During the last 7 days, how much time did you usually spend sitting on a weekday?

_____ hours per day，_____ minutes per day

5.14. Did you use sport watch or app for record steps or heart rate?

□Yes □ No

If yes, the name of sport watch is_____, the name of the sport app is_____

6. Others

6.1. Are you satisfied with your current living conditions?

□Cannot be more satisfied □Basically satisfied

□Ordinary □Dissatisfied □Very dissatisfied

6.2. Did you experience the events that have a significant impact on your life in the past two years, such as those listed below?

□Marital separation/divorce □Serious trauma or car accident

□Unemployment / laid-off / retirement □Death of spouse

□Serious family diversity and conflicts □Violent attacks / rapes

□Loss of economic resources / liabilities

□Bankruptcy of self-owned business or family economic breakdown

□Death or serious diseases of other family members

□Serious natural disasters (such as drought, waterlogging, etc.)

□None

6.3. In the past year, are you under great mental stress in work and life?

□No pressure □Little pressure □Ordinary

□Great pressure □Extremely great pressure

6.4. In the past one year, is any change in your body weight?

□No □Add at least 2.5kg □Lose at least 2.5kg

6.5. In the past one year, do you using drugs or controlling diet intake in order to lose weight?

□Yes □No

6.6. Could you remember your body weight when you was at age of 25?

_____kg; □Not applicable

Signature_____

Variable category	Name of variable	Normal limits or categories	Definition of variables	Data resources
Primary Outcome	body mass index	18.5-24kg/m2	outcome	calculate from health examination information
	daily steps in one month		mediator and outcome	Wechat mini application
Secondary Outcome	fasting blood glucose (GLU)	3.6-6.1 (mmol/L)	outcome	health examination
	total cholesterol (TC)	3.1-5.7 (mmol/L)	outcome	health examination
	triglyceride (TG)	0.4-1.73 (mmol/L)	outcome	health examination
	low density lipoprotein cholesterin (LDL-C)	2.07-3.1 (mmol/L)	outcome	health examination
	high density lipoprotein cholesterin (HDL-C)	0.9-2 (mmol/L)	outcome	health examination
	body composition	mass percentage of fat	outcome	health examination
Other variables	height			health examination
	weight			health examination
	age	16 - 65 years old	possible confounding	questionnaire
	gender	male； female	possible confounding	questionnaire
	job		possible confounding	questionnaire
	education	under primary school; primary school, middle school; bachelor; master and above	possible confounding	questionnaire
	WalkScore corresponding to home address	0-100	exposure	calculate from questionnaire information
	WalkScore corresponding to workplace address	0-100	exposure	calculate from questionnaire information
	smoking status	giving up; never; sometimes smoke; frequently smoke	other factors will influence outcome	questionnaire
	alcohol consumption	giving up; never; sometimes drink; frequently drink	other factors will influence outcome	questionnaire
	online food order habit	never; sometimes order; frequently order	possible confounding	questionnaire
	eating diet	more details showed in questionnnaire	other factors will influence outcome	questionnaire
	physical activity	more details showed in questionnnaire	possible confounding	questionnaire

The name of health examination	Specific name of items	Normal limits or result categories
Five items of thyroid function	Free triiodothyronine (FT3)	2.0-6.6 pmol/L
	Free thyroxine (FT4)	10.3-31.9 pmol/L(0.8~2.3ng/dL)
	Thyroid-stimulating hormone (TSH)	0.3-4.5 uIU/mL
	Total triiodothyronine (TT3)	1.8-2.9 nmol/L(115~190ng/dL)
	Total thyroxine (TT4)	65-155 nmol/L(5.0~12.0μg/dL)
12-leads electrocardiogram		N=Normal; A=abnormal
Ultrasound (splenorenal major abdominal and portal vein)		
	Liver	N=Normal; A=abnormal
	Gallbladder	N=Normal; A=abnormal
	Pancreas	N=Normal; A=abnormal
	Spleen	N=Normal; A=abnormal
	Bilateral kidneys	N=Normal; A=abnormal
	Portal vein	N=Normal; A=abnormal
Carcinoembryonic antigen (CEA)		0-5 (ng/ml)
Liver function	Albumin (Alb)	38-51 (g/L)
	Albumin/Globulin	1.2-2.5
	Gamma-glutamyl transpeptidase (GGT)	4-50 (IU/L)
	Alanine amino transferase (ALT)	0-42 (IU/L)
	Aspartate amino transferase (AST)	0-42 (IU/L)
	Alkaline Phosphatase (ALP)	34-114 (IU/L)
	Globulin (G)	25-38 (g/L)
	Total protein (TP)	66-83 (g/L)
Alpha-fetoprotein (AFP)		0-20 (ng/ml)
Urine routine	Potential of hydrogen (PH)	4.6-8.0
	Urine leukocyte (LEU)	Negative or positive
	Specific grvity (SG)	1.003-1.03
	Bilirubin (BIL)	Negative or positive
	Urobilinogen (URO)	N=Normal; A=abnormal
	Urine protein (PRO)	Negative or positive
	Urine Casts	Negative or positive

	Urine erythrocyte (ERY)	Negative or positive
	Urine pus cells	Negative or positive
	Urine colour	Negative or positive
	Uroepithelial cell (U-Epc)	Negative or positive
	Urine sugar (U-GLU)	Negative or positive
	Urine ketone (KET)	Negative or positive
	Urine nitrite (NIT)	Negative or positive
	Urine transparency	Negative or positive
	Urinary mucous silk (U-MUCS)	Negative or positive
	Creatinine (CR)	45-84 (μmol/L)
	Blood urea nitrogen (UN)	1.7-8.3 (mmol/L)
	Uric acid (UN)	155-428 (μmol/L)
	Fasting blood glucose (GLU)	3.6-6.1 (mmol/L)
	Serum cystatin c (Cys-c)	0.5-1.1 (mg/L)
Blood routine		
	white blood cell (WBC)	3.5-9.5 (10*9/L)
	Percent monocytes (MON%)	3-10 (%)
	Monocytes (MON)	0.1-0.6 (10*9/L)
	Red blood cell (RBC)	3.8-5.1 (10*12/L)
	Red blood cell distribution width (SD)	11-16 (%)
	Red blood cell distribution width (CV)	37-54 (fL)
	Hematokrit (HCT)	35-45 (%)
	Percent lymphocyte (LYMPH%)	20-50 (%)
	Lymphocyte count (LYMPH)	1.1-3.2 (10*9/L)
	Mean corpuscular volume (MCV)	82-100 (fL)
	The average RBC hemoglobin content (MCH)	27-34 (pg)
	The average RBC hemoglobin concentration (MCHC)	316-354 (g/L)
	mean platelet volume (MPV)	9-13 (fL)
	Basophilic cell percentage (BAS%)	0-1 (%)
	absolute basophil count (BAS)	0-0.06 (10*9/L)

	Acidophilic cell percentage (EOS%)	0.4-8 (%)
	Acidophil number (EOS)	0.02-0.52 (10*9/L)
	Hemoglobin (HGB)	115-150
	Platelet distribution width (PDW)	9-17 (%)
	blood platelet count (PLT)	125-350 (10*9/L)
	Thrombocytocrit (PCT)	N (%)
	Neutrophilic granulocyte percentage (NEU%)	40-75 (%)
	Neutrophilic granulocyte count (NEU)	1.8-6.3 (10*9/L)
Blood lipid		
	Total cholesterol (TC)	3.1-5.7 (mmol/L)
	Triglyceride (TG)	0.4-1.73 (mmol/L)
	Low density lipoprotein cholesterin (LDL-C)	2.07-3.1 (mmol/L)
	High density lipoprotein cholesterin (HDL-C)	0.9-2 (mmol/L)
Two pairs of semi - hepatitis B		
	Hepatitis B e antibody (HBe)	Negative or positive
	Hepatitis B e antigen (HBeAg)	Negative or positive
	Hepatitis B surface antibody (HBs)	Negative or positive
	Hepatitis B surface antigen (HBsAg)	Negative or positive
	Hepatitis B core antibody (HBc)	Negative or positive
Ultrasound(bilateral mammary gland)		N=Normal; A=abnormal
Ultrasound(uterus, annex)		N=Normal; A=abnormal
Vaginal secretion examination	Trichomonad	Negative or positive
	Mycete	Negative or positive
	Cleanliness of leucorrhea	Negative or positive
Thinprep cytology test(TCT)		N=Normal; A=abnormal
Body composition		Mass percentage of fat, protein, and water

Supplementary Table 1. The timeline of study conduction

Approval of ethic committee	2018 July 10th
Completion of clinical registration on Chinese Clinical Trial Registry Platform	2018 August 9th
Date collection of demographic data and home/workplace addresses of participants	2019 October
Development of Wechat mini App for recording daily steps	2020 January
Previous data checking and data collection of questionnaire and health examination of participants	2020 March-May
Date collection of daily steps of participants by Wechat mini App	2020 June
Follow-up: Data collection of questionnaire, health examination of participants, and daily steps in one month	2020 December – 2021 February
Follow-up: Data collection of questionnaire, health examination of participants, and daily steps in one month	2021 December – 2022 February
Follow-up: Data collection of questionnaire, health examination of participants, and daily steps in one month	2022 December – 2023 February

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract P2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found P2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported P3
Objectives	3	State specific objectives, including any prespecified hypotheses P3
Methods		
Study design	4	Present key elements of study design early in the paper P5-P6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection P4-P7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up P4-P5 *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed P6 *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable P4-P7
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 P6-P7
Bias	9	Describe any efforts to address potential sources of bias P6-P7
Study size	10	Explain how the study size was arrived at P6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why P7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding P7
		(*b*) Describe any methods used to examine subgroups and interactions P7
		(*c*) Explain how missing data were addressed P7
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed P7 *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses P6

Continued on next page

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
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount) P7
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
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
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias P7
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence P7
Generalisability	21	Discuss the generalisability (external validity) of the study results P7
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

*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.

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The effects of walkability on physical activity and obesity: a prospective observational study protocol

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The effects of walkability on physical activity and obesity: a prospective observational study protocol

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Abstract

Introduction

The prevalence of overweight and obesity is increasing worldwide, which could lead to a set of chronic and metabolic diseases. Physical activity is a modifiable factor for obesity, which was reported to be correlated with built environment. However, the effects of built environment on physical activity are not consistent. Walkability is a convenient way to assess built environment. We aim to prospectively explore the relationship among walkability, physical activity, and obesity in Chinese participants in Chongqing, and provide evidence for future urban planning.

Methods and analysis

Participants will be recruited from people who receive health examination in the Health Management Centre, the First Affiliated Hospital to Army Medical University. Exposure variables are WalkScores calculated within the areas around workplace and residential addresses of participants. The primary outcomes are body mass index (BMI) measured through health examination at baseline and daily walking steps recoded by WeChat mini application for 30 days at follow-ups. Other health-related data of the participants will also be collected. Multivariate regression analysis will be performed to examine the relationship between exposure variables and outcomes.

Ethics and dissemination

The Protocol is approved by the Ethics Committee of the First Affiliated Hospital to Army Medical University (KY201839). The results will be actively disseminated through peer-review journals and conference publications.

Strengths and limitations of this study

-This study innovatively evaluates the effects of walkability on physical activity and obesity in a hilly city.

-The daily walking steps were recorded by a novel method --- WeChat mini application.

-This combines the data collected from health examination and cellphones.

-One limitation is it would fail to record data during swimming and other physical activities.

-The other limitation is the maximum time for data collection is 30 days after one authorization.

Introduction

The prevalence of overweight and obesity has doubled worldwide since 1980, which is currently 5% in children and 12% in adults. [1] In 2015, the number of children and adults who suffered from obesity was 107.7 million and 603.7 million, respectively.[2] High body mass index (BMI), an indicator for obesity, was identified to be a risk factor for various chronic diseases, including cardiovascular disease, diabetes, chronic kidney disease, and cancers.[2] Chinese Health and Nutrition Survey showed the rate of obesity and overweight in adults increased from 25.1% to 39.6% from 1997 to 2009.[3] The updated prevalence of overweight and obesity were reported to be 25.8% and 7.9%, respectively, in 2017.[4] It is reported that the obesity rate in Chongqing in Southwestern China is 10.3%.[5], [6]

One of the modifiable risk factors of obesity and chronic diseases is physical inactivity.[7-8] Physical inactivity is partly due to insufficient activity during leisure time and an increase in sedentary behavior during occupational and domestic activities.[9] Additionally, an increase in the use of "passive" modes of transport has also been associated with declining physical activity levels, which means less walking or any human powered movement in daily life.[9] Insufficient physical activity contributes to 6% of the disease burden of coronary heart disease, 7% of that of type 2 diabetes, 10% of that of breast cancer, and 10% of that of colon cancer.[10] As reported, more than 533,000 deaths and more than 1.3 million deaths could be averted annually by reducing the prevalence of physical inactivity by 10% and 25%, respectively.[10] Thus, in order to ameliorate physical inactivity, it is crucial to understand its associated factors and determinants. The factors associated with physical activity in high-income countries were reported to be age, sex, health status, self-efficacy, genetic factors, and motivation.[11] At the level of population, the factors outside health sectors have been identified to be causally related to physical inactivity, for example, urban planning, transportation system, and built environment.[11-13]

Walkability is a useful tool in the process of evaluating the effects of the built environment on physical activity.[14] However, there have been inconsistence with respect to built environment, walkability, physical activity, and health. A study published in *Nature* in 2017 with more than 700 thousand participants and 68 million days recorded revealed that higher walkability was associated with more daily walking steps, whose effect was stronger for females.[14] Porter and colleagues also indicated in a cohort study with 688 participants that as one aspect of the neighborhood environment, walkability was associated with physical activity among pregnant women.[15] Other studies from Japan and North America also supported the positive effects of built environment on physical activity.[16-18] In a middle size city Bengbu in Eastern China, researchers observed about at least 30% lower risk of cardiovascular diseases were associated with moderate to high levels of WalkScore, compared with controls with low WalkScore, in which WalkScore is a measure of walkability.[19] However, a cohort study with 1819 households investigating moving to the former Olympic athletes' village in London discovered no effect associated with this living environment change on daily walking steps, indicating that ameliorating the built environment might be insufficient to enhance physical activity.[20] A study with 161 older adult participants in Canada also showed that walkability was not associated with physical activity volume or intensity.[21] A study in a small city in China called Yuncheng also

showed no positive associations of land-use mix and walking duration.[22] In addition to these inconsistent evidence, there is no research of walkability effects on physical activity and health in China.

The factors of walkability usually include residential housing units, retail shops, public transportation, street-level movement density, the distance to behavior-related destinations.[23] Residential housing units are a house, apartment, group of rooms, or a single room for occupancy as a separate living unit, which could predict the population allocation in an area.[24] Retail shops are one kind of points of interest, which serve for non-residential uses and can enhance the motivation of walking.[25] Street accessibility, which are represented by the street-level movement density and the distance to behavior-related destinations, as well as the proximate access to public transportation are crucial characteristics of a walkable neighborhood.[26] Some studies also take into account the population density, the street connectivity, land-use diversity, infrastructure and safety for walking, aesthetics, and crime influence.[27-29] WalkScore (www.WalkScore.com) is a user-friendly open composite walkability index. It could evaluate the walkability of a mail address or a city and is widely used in the studies investigating the relationship between walkability and health status.[14, 30]

The evaluation of the walkability of a community and its effects on physical activity and health status of the residents in China could shed a light on urban design, laying a foundation for future urban planning policy and physical activity promotion interventions. Additionally, there is a gap of research on the influences of walkability on the physical activity in a hilly city. This protocol is an observational, prospective cohort study of participants who receive physical examination in the First Affiliated Hospital to Army Medical University. The aim of this study is to analyze the relationships among walkability, physical activity, and obesity in the residents in Chongqing for future urban planning reference. A map and photos with the hilly topography of Chongqing are showed in Supplementary Figure 1. Our research hypothesis is that high WalkScore will be associated with the decrease of BMI. The daily walking steps and metabolic profiles will be the mediators through the effect pathway from WalkScore to BMI. We illustrate our hypothesis of causal diagram in Supplementary Figure 2.

Materials and Methods

Study design and setting

The location of our protocol is Chongqing, a Chinese city, with multi-commercial centres, which is characterized by a unique hilly topology with two rivers, Yangtze and Jialing.[31] Blood samples, clinical data, addresses, and related variables are collected prospectively from participants who receive physical examination in the Health Management Centre, First Affiliated Hospital to Army Medical University, Chongqing. Clinical and demographic data are recorded in the hospital's database. The daily walking steps of participants are collected by WeChat mini application. Blood samples are examined by the clinical laboratory of the hospital. The addresses and the part of listed variables in Table 1 will be collected by a questionnaire referred to a comprehensive cohort study named China Kadoorie Biobank study.[32] Participants will be recruited from October

2019 to 2020 and followed up till 2023. The recruitment period will be extended if necessary. Moreover, we will include the participants who had pre-existing appointment if he/she meets the inclusion/exclusion criteria. We need to require this kind of participants to provide home and workplace addresses on the first visit and fill questionnaire on the second visit after recruitment. The recruitment process can be referred to Figure 1.

176 Table 1. All measured variables.

Variable category	Name of variable	Normal limits* or categories	Definition of variables	Sources of data
Primary outcomes	Body mass index	18.5-24kg/m2	Outcome	Calculate from health examination data
	Daily walking steps in one month		Outcome and mediator	Wechat mini application
Secondary outcomes	Fasting blood glucose (GLU)	3.6-6.1 (mmol/L)	Outcome	Health examination
	Total cholesterol (TC)	3.1-5.7 (mmol/L)	Outcome	Health examination
	Triglyceride (Tg)	0.4-1.73 (mmol/L)	Outcome	Health examination
	Low density lipoprotein cholesterin (LDL-C)	2.07-3.1 (mmol/L)	Outcome	Health examination
	High density lipoprotein cholesterin (HDL-C)	0.9-2 (mmol/L)	Outcome	Health examination
	Body composition	Mass percentage of fat	Outcome	Health examination
Exposure variables	WalkScore corresponding to home address	0-100	Exposure	Calculate from questionnaire information
	WalkScore corresponding to workplace address	0-100	Exposure	Calculate from questionnaire information
Other variables	Height			Health examination
	Weight			Health examination
	Age	16 - 65 years old	Possible confounding	Questionnaire
	Gender	Male；female	Possible confounding	Questionnaire
	Job		Possible confounding	Questionnaire
	Education	Under primary school;	Possible confounding	Questionnaire

		primary school, middle school; bachelor; master and above		
	Smoking status	Giving up; never; sometimes smoke; frequently smoke	Other factors will influence outcome	Questionnaire
	Alcohol consumption	Giving up; never; sometimes drink; frequently drink	Other factors will influence outcome	Questionnaire
	Online food order habit	Never; sometimes order; frequently order	Possible confounding	Questionnaire
	Eating diet	More details showed in questionnaire	Other factors will influence outcome	Questionnaire
	Physical activity	More details showed in questionnaire	Possible confounding	Questionnaire

*"Normal limits" means in these limits, the corresponding condition is normal, otherwise it suggests there may be some health concerns or some errors.

Participants

This is an open cohort study. Participants are eligible for inclusion if they satisfy the following criteria: an age between 16 and 65, using smart phones, habitual residents in the downtown area of Chongqing.

The exclusion criteria will be: 1. participants with the symptoms or signs of cardiovascular and cerebrovascular diseases, such as chest tightness, shortness of breath, and even chest pain, especially those whose symptoms get worse when climbing stairs or walking fast; 2. participants with diagnosed heart diseases, such as coronary heart diseases, hypertensive heart diseases, valvular heart diseases, and pulmonary heart diseases, who need to exercise based on principles of cardiac rehabilitation; 3. participants with other severe complications of diabetes, such as those with vision severely affected by eye diseases, those with balancing ability affected by peripheral neuropathy, those with diabetic foot, and those with renal dysfunction; 4. participants whose movement is affected by musculoskeletal disorders, e.g. patients with musculoskeletal disorders and cardiopulmonary dysfunction; 5.participants who refuse to provide corresponding information, or are not able to complete the questionnaire and health examination; 6.participants who plan to migrate to other areas or leave for a long time (more than one year); 7.participants with secondary morbid obesity caused by congenital diseases, metabolic diseases, neurologic diseases and endocrine diseases. Participant inclusion and follow-up will be checked by the health managers and nurses in the Health Management Centre. Participants must be able to sign written informed consent after acknowledging the benefits and risks of this study.

The number of the sample size was calculated using the following formula:

$$n = \frac{\left(z_{\alpha}\sqrt{2\overline{pq}} + z_{\beta}\sqrt{p_0 q_0 + p_1 q_1}\right)^2}{\left(p_1 - p_0\right)^2}$$

The parameters used in the calculation are： p_0 (the obesity prevalence in control group) as 10.3%,[6] the supposed risk ratio (RR) between groups with high WalkScore and low WalkScore as 0.5, $\alpha = 0.05$， and $1-\beta = 0.9$. In this formula, $p_1 = p_0 * RR = 5.15\%$, $\bar{p} = (p_0+p_1)/2$, $\bar{q} = 1-\bar{p}$, $q_0 = 1-p_0$, and $q_1 = 1 - p_1$, $Z_{\alpha} = 1.96$, and $Z_{\beta} = 1.282$. Based on these parameters, the sample size in exposure group and control group should be 400, respectively. Concerning the possibility of loss of follow-up, we increased the sample size by 10% to 440 participants in each group. The final sample size is 880 in total.

Clinical data

The questionnaire filled by participants under nurses' guidance includes the questions of participant demographics, exposure, and lifestyle factors. We attached the full version of the questionnaire in Supplementary File 1. The measured variables, primary outcome, and secondary

outcomes, exposure variables, as well as possible confoundings are listed in Table 1. The variables in detail are showed in Supplementary File 2. The relationships among different variables are illustrated in a causal diagram in Supplementary Figure 2.

During the process of recruitment, the following data were collected by the questionnaire and health examination procedure as well as Wechat mini application:

1. Primary outcomes: Body mass index (BMI), and everyday walking steps are recorded by a WeChat mini application. Every year, the daily walking steps in 30 days will be collected after physical examination in the hospital. BMI was calculated by the weight in kilograms divided by the square of the height in meters. Overweight and obesity were defined as a BMI of 24–27.9 kg/m^2 and a BMI ≥ 28 kg/m^2, respectively.[4] The participants will authorize the application in order to allow the researchers in this study to obtain the daily walking steps in 30 days collected by the WeChat mini application.
2. Secondary outcomes: metabolic profiles by blood tests; for example, cholesterol levels and blood glucose. Body composition was measured by a machine named inbody 220, when doing the measurement in which, the participants will stand on the machine without shoes and hold the two poles of the machine for five minutes.
3. Exposure variables: Walkscores which will be calculated based on the workplace address and residential address of the participants.
4. Participant demographics: age, gender, height, marital status, and education.
5. Lifestyle factors: smoking status, alcohol consumption, online food order habit, eating diet, and physical activity
6. Identification of non-communicable diseases: e.g. hypertension, coronary artery disease, and diabetes.

Biological samples and assay methods

The blood samples are collected by nurses in the Health Management Centre in the morning. The participants should be fasting for 12 to 14 hours before health examination. A sum of 5mL blood was collected in the yellow tube with inert separating gel for cholesterol and glucose testing. A total of 2mL blood for blood routine test was stored in a purple tube with ethylenediaminetetraacetic acid (EDTA) as anticoagulant. The blood samples are analyzed by automated biochemical analyzer, with the series number of Beckman AU5811. Total cholesterol was tested by the cholesteroloxidase (CHO) enzyme method. Triglyceride was tested by the glycerol phosphate dehydrogenase and peroxidase (GPO-POD) method.

Physical examination

The physical examination included the measurement of height, body weight, blood pressure, and body component following the guidelines of the Health Management Centre. The blood pressure was evaluated by electronic sphygmomanometer (Omron, type： B-203RV III C). The machine Inbody 220 was used to analyze body component.

WalkScore

WalkScore measures pedestrian friendliness by analyzing the distance to points of interest and the weights of points of interest. Data sources are from Google, Factual, Great Schools, Open Street Map, the U.S. Census, Localeze, and places added by the Walk Score user community.[33] The algorithm of WalkScore is not disclosed in its official website. The formula[34] of WalkScore illustrated in Tsinghua University is

$$\sum_{i=1,j=1}^{m,n}(W_i * S_{i,j} * D_{i,j}) * \frac{100}{15}.$$

W_i is the weight of one kind of amenity. Table 2 shows the weights of different amenities.

Amenity category	Weight	Amenity category	Weight	Amenity category	Weight
convenience store	3	café/teahouse	2	school	1
restaurant	3	bank	1	bookstore	1
shop	2	park	1	entertainment places	1

Table 2. Weights of different amenities.

The letter of i stands for different kinds of amenities. The letter of j stands for different walking distance. $S_{i,j}$ stands for service scope of a specific amenity. $D_{i,j}$ stands for the attenuation coefficient based on distance from the calculated point to an amenity. Table 3 shows the attenuation coefficients based on the distances from the calculated point to an amenity.

Distances	Attenuation coefficients
<400 metres	1
400-800 metres	0.9
800-1200 metres	0.55
1200-1600 metres	0.25
1600-2400 metres	0.08
>2400 metres	Out of scope, which will not be calculated.

Table 3. Attenuation coefficients based on the distances.

The calculation of WalkScore is free, to obtain which we could type the name of calculated point into the official website and wait for the score. The limit of the score is 0-100. The WalkScore of residential address and workplace address will be calculated separately.

The following Table 4 describes the meanings of different WalkScore.

WalkScore	Description
90 - 100	Walker's Paradise: Daily errands do not require a car.

70 - 89	Very Walkable: Most errands can be accomplished on foot.
50 - 69	Somewhat Walkable: Some errands can be accomplished on foot.
25 - 49	Car-dependent: Most errands require a car.
0 - 24	Almost all errands require a car.

Table 4. Interpretations of different WalkScore.

Wechat mini application

Wechat is a cellphone application for communication used by more than a billion people.[35] The customers of it can send voice, video, photos, and text. On the basis of Wechat and its great number of users, the company of Wechat opens the resources to the public of developing different kinds of Wechat mini applications. Users could link its Wechat ID to Wechat mini application without download installment package and achieve data sharing through Wechat mini application. Wechat could also extract daily step data from users' cellphones after user's agreement. Through Wechat mini application, we could extract the daily walking steps of Wechat users in one month after customer agreement. After we develop the Wechat mini application following the guideline from Wechat and publish it, the participants could open the Wechat mini application in their Wechat and signed a consent to agree that they are willing to allow us extract daily steps. Then, the customers' daily step information will be delivered to our datasets automatically. The obtained data will be consistently with the records in participants' cell phones.

Statistical methods

The data analysis will be conducted after data collection in 2020. The prospective analysis will be implemented in 2023. Descriptive statistics is performed to analyze the distribution of the data. Missing data were addressed by deletion or last observation carried forward based on specific case status. Single variable analysis will be implemented to analyze the correlations between exposures, possible confoundings (i.e., online food order habit, education, job, physical activity), and outcomes. The participants will be divided into five groups by the categories of the WalkScore with regard to workplace address and residential address, respectively. The lifestyle factors and outcomes will be compared among groups. All the variables in causal diagrams will be compared between baseline and follow-ups. T-test will be used for the continuous variables, and Chi-square test or Analysis of Variance (ANOVA) will be used for categorial variables. Multivariate linear regression will be conducted taken BMI and daily walking steps as dependent variables, respectively, as cross-sectional analyses, after data collection in 2020. Further longitudinal analyses with G estimation and inverse probability weight analysis will be conducted after data collection in 2023 in order to take into account the effects of confounders whose conditions may change over time. Sensitivity analysis will be implemented by bootstrap method. With replacement from the original dataset, the bootstrap method enables estimation of the accuracy of an estimator by random sampling. The first step is to determine the ranges and variations of the independent variables, which are input into our multivariate linear regression.

The second step is to generate independent variables based on the Sobol sequence by R package ''randtoolbox''. The final step is to collect and process the simulation results, which can be used in sensitivity analysis through conducting multivariate linear regression.[36]

Patient and public involvement

Our study is an observational study without intervention on participants. The development of the research question and outcome measures were informed by participants' priorities, experience, and preferences on the basis of informed consents. There is no participants' involvement in the study design. We recruit participants when conducting the study, but participants would not be the conductor of the study. The results are planned to disseminate to study participants.

Ethics and dissemination

The Protocol is approved by the Ethics Committee of the First Affiliated Hospital to Army Medical University (KY201839). All the participants will receive consultation about the benefits and possible risks of the study from health managers and nurses, and endow written informed consent before enrollment. All the participants will be informed that they can withdraw from the study at any time for any reason. The withdrawal cases will be discarded and related information will be deleted from the database of the study.

The sample volume of blood for the study is 11 per participant-visit and maximum 55 for five years. The blood sampling process is part of the procedure of physical examination and this study acquires the data use authority after the recruitment. The participants will be contacted and informed the results of the physical examination. The researchers of this study will be responsible for implementing the study adhering to the Declaration of Helsinki.

We plan to analyze and publish study results according to the STROBE guidelines. Results will be published in international and peer-reviewed scientific journals. Negative, positive, conclusive or inconclusive results will be published.

Study Status

We collected demographic data, home addresses, and workplace addresses of participants in October 2019. We plan to check previous data and collect the data of health examination and questionnaire of participants in March to May 2020 and daily walking steps of participants by Wechat mini application in 2020 (in one month after health examination). We will continue follow-up in 2021-2023. The follow-up will be sustained by contacting with participants and requiring body examination by phone. Currently, the daily walking steps collector of the WeChat mini application has been developed. The study was registered in Chinese Clinical Trial Registry (ChiCTR) and the registration number is ChiCTR1800017680. The date of the study in a timeline is showed in Supplementary Table 1. There will be six waves of date collection.

Discussion and potential limitations

This observational and prospective study could innovatively provide evidence of the relationship among walkability, obesity, and physical activity in China. It will also provide evidence of the influence of built environment on physical activity in a hilly city, Chongqing. We hypothesized that the walkability, physical activity, and obesity status are strongly associated with each other. The use of WeChat mini application in data collection process have a lot of advantages. Through extracting data from cellphones' records, the data collection is very convenient and cost-effective which eliminates the errors of manual typing. The participants will sign informed consents before recruitment and sign an agreement to endow Wechat mini application to collect their daily steps before the use of Wechat, in which way we could ensure the process meets the ethic requirements.

There are some limitations in the collection of physical activity. The WeChat mini application can only record the daily walking steps when the participants walk with their phone. Like other studies, activities without carrying phones such as swimming and ball games will not be recorded in the data collection procedure.[14] Moreover, more than 30 days' collection needs second authorization (the maximum data collection time is 30 days after one authorization) which is less adherent; thus the researchers could only collect the data of 30 days for convenience. In order to compensate for this limitation, the participants will be recruited all year round and the researchers will ask for a second authorization of daily step collection in the follow-up visit. In terms of season, the season when we do the data collection may also influence the number of daily steps. We will consider season as a confounder in future data analysis.

Moreover, WalkScore is based on an online calculation website which has not opened the algorithm officially. Other walkability evaluation tools such as Pedestrian Environment Quality Index (PEQI) depend on the evaluation of geographic information system (GIS), the score process of which is relatively clean; however, the practice is more complex.[37-39] Thus, we decide to choose WalkScore for the primary analysis. If the results could indicate the relationship between walkability and obesity, we could further analyze the component factors of walkability in following analysis.

Legends

Figure 1. Flow chart of study.

Supplementary Figure 1A. Chongqing map.
It is the nine main districts of Chongqing extracted from Open Street Map. The black point shows the location of the First Affiliated Hospital to Army Medical Univerisity in Shapingba District. Shapingba District is an old town with a lot of renowned high schools and universities.

Supplementary Figure 1B. Chongqing location.
It shows the location of Chongqing relative to the other cities (Chengdu, Suining, Zigong, Jianyang, and so on). The topography of Chongqing is more hilly than that of Chengdu.

Supplementary Figure 2. Causal diagram of measured variables.
Obesity and overweight is the primary outcome. WalkScore is the exposure variable. The participants will be divided into five groups by the categories of the WalkScore with regard to workplace address and residential address, respectively (In this way, we decide the exposure degree). Daily walking steps and metabolic profiles are the mediator from WalkScore to obesity. Job and education are possible confoundings between WalkScore and daily walking steps. Physical activity and mental health scores are possible confoundings between daily walking steps and metabolic profiles. Online food order habit is possible confounding between WalkScore and metabolic profiles. Eating habit, smoking, and alcohol consumption are other factors, which will influence metabolic profiles.

Supplementary Table 1. Timeline of study conduction.

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Competing interests: All authors have completed the ICMJE uniform disclosure form at http://www.icmje.org/coi_disclosure.pdf and declare: no support from any organization for the submitted work; no financial relationships with any organization that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work.

Contributors: SC and YZ are joint first authors. SC contributed to study concept and design. SC wrote the first draft of the protocol manuscript. ZC supervised the process. YZ and JS revised the manuscript after feedback from all authors. YZ coordinates the conducting of this study. All authors reviewed the manuscript and approved the final version of the manuscript.

Data sharing statement: No additional data are available.

Patient consent: Consent will be obtained in the enrollment process.

Ethics approval: The Protocol is approved by the Ethics Committee of the first affiliated hospital to Army Medical University (KY201839).

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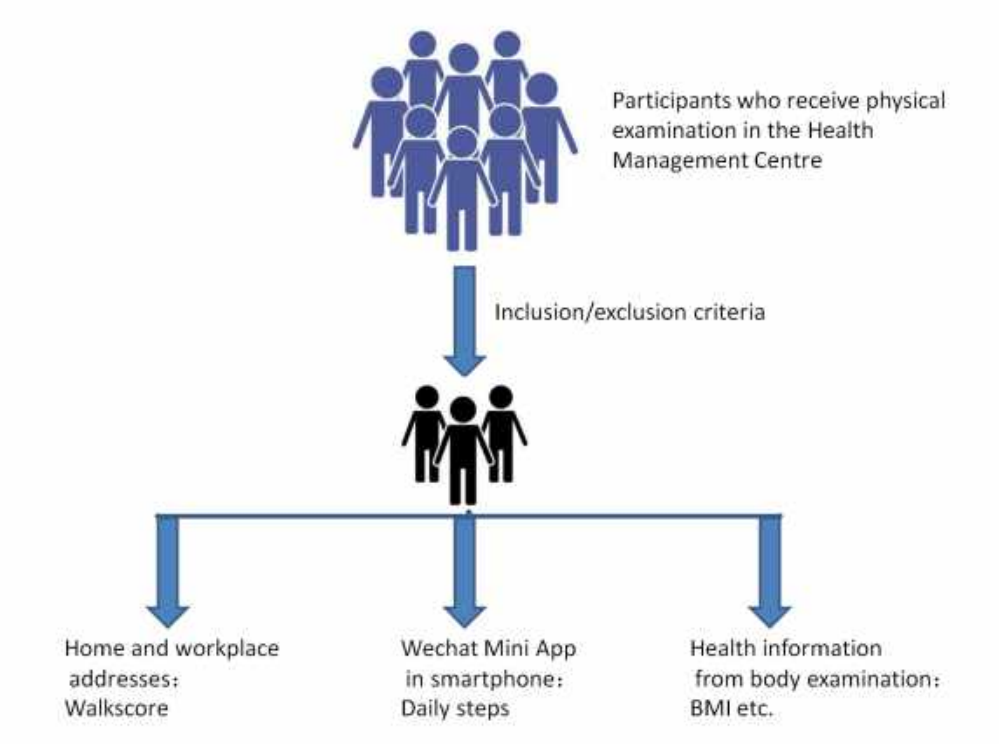

Figure 1. Flow chart

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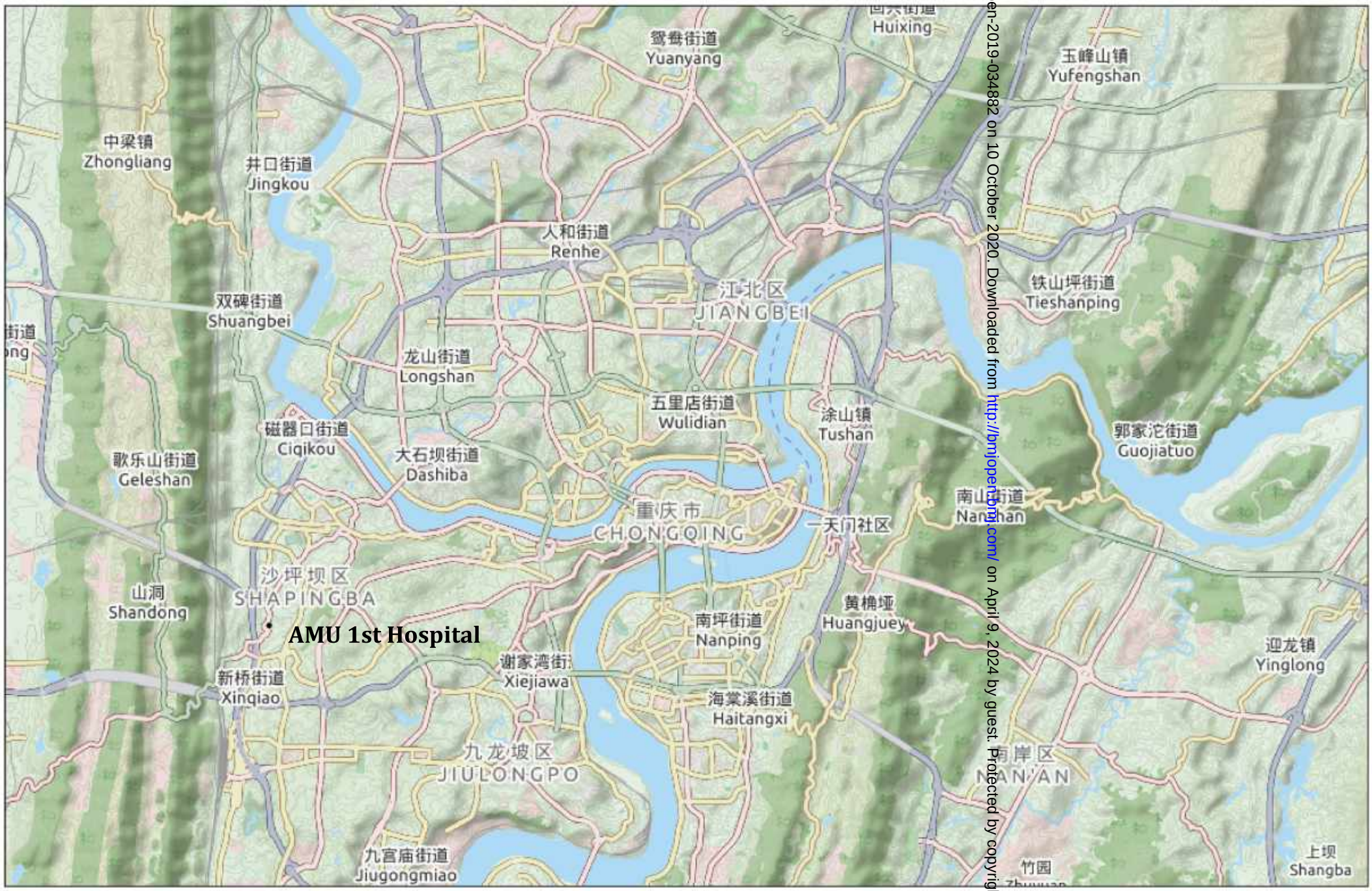

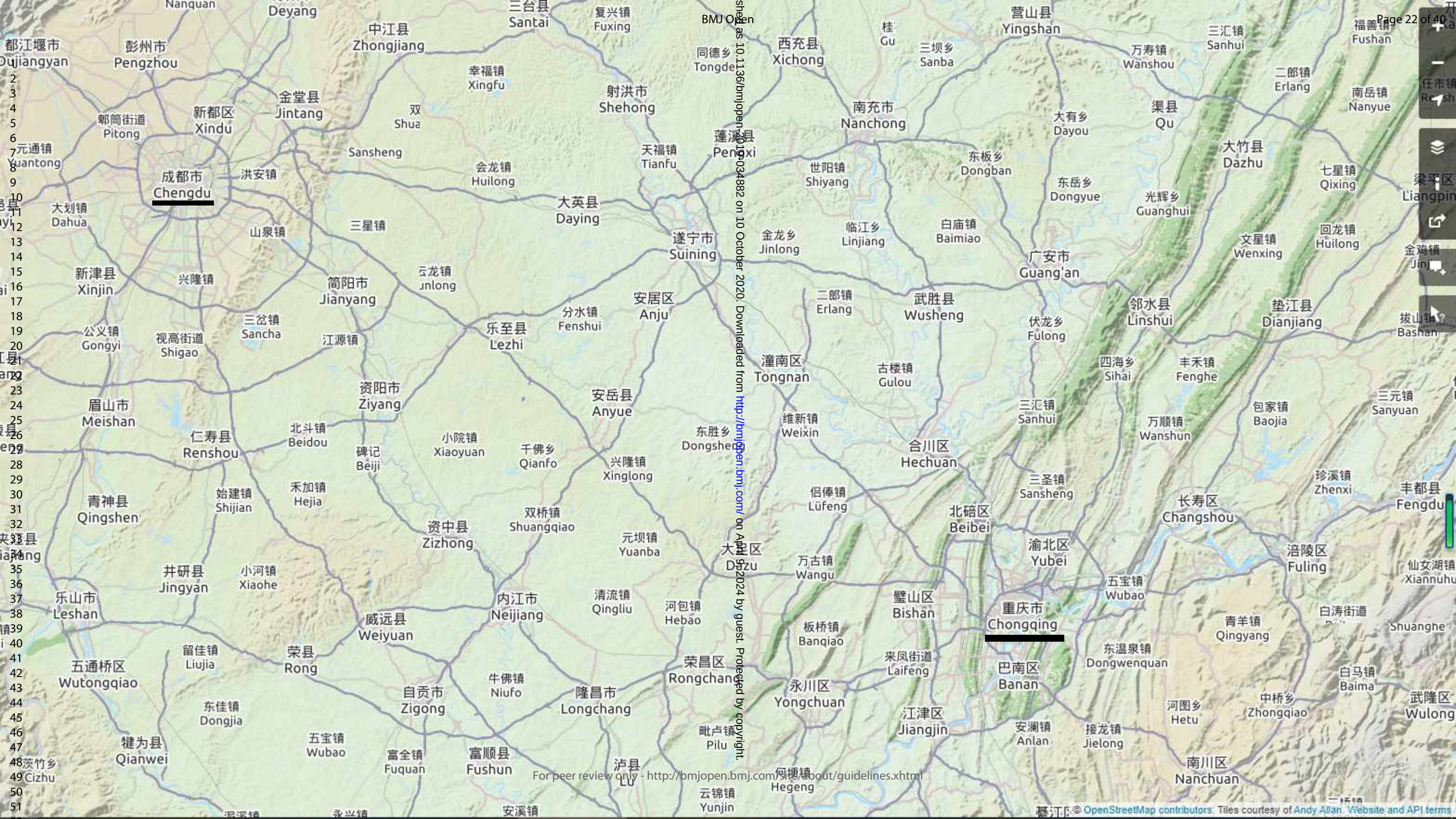

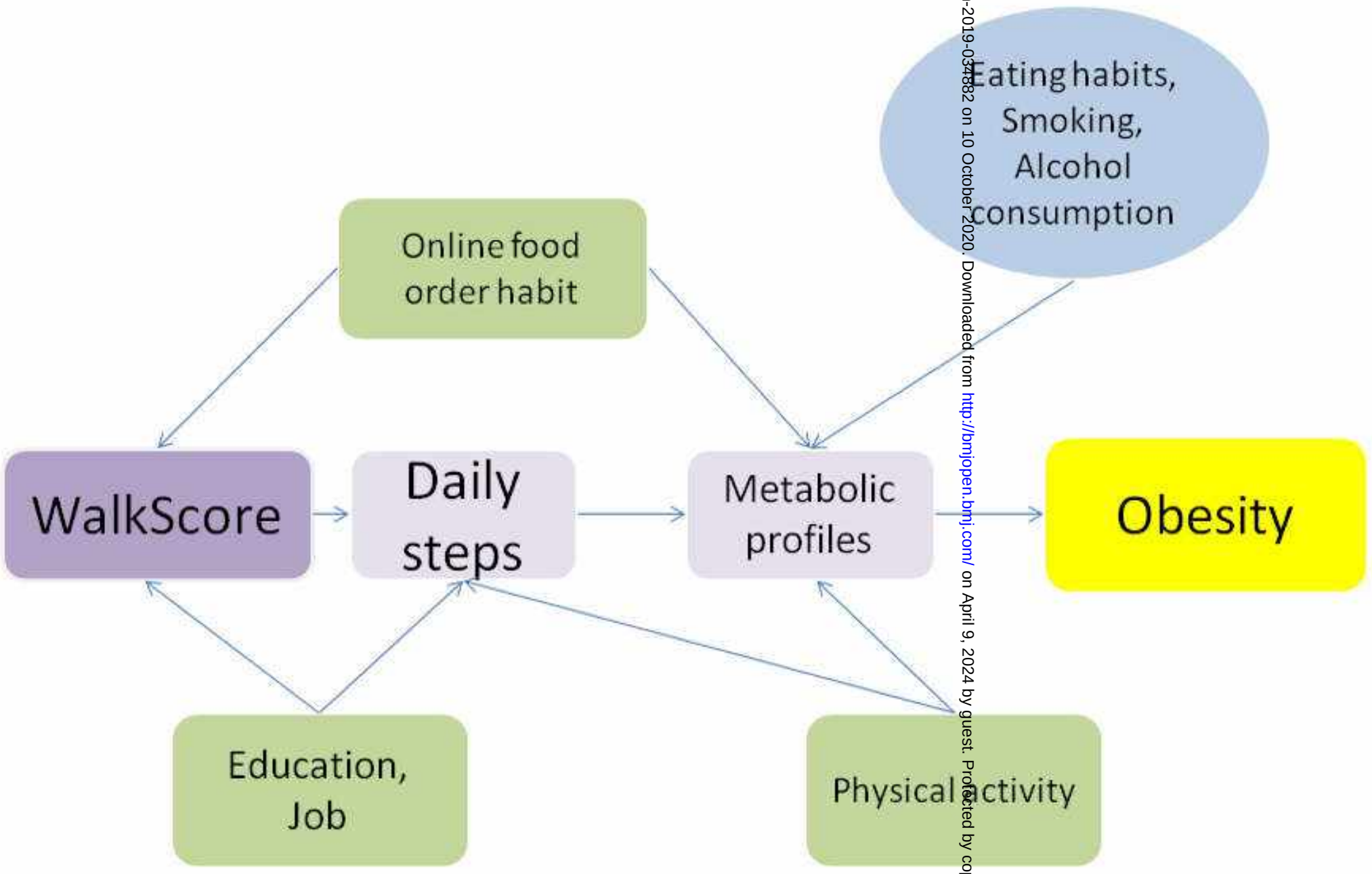

Supplementary Table 1. The timeline of study conduction

Approval of ethic committee	2018 July 10th
Completion of clinical registration on Chinese Clinical Trial Registry Platform	2018 August 9th
Date collection of demographic data and home/workplace addresses of participants	2019 October
Development of Wechat mini App for recording daily steps	2020 January
Previous data checking and data collection of questionnaire and health examination of participants	2020 March-May
Date collection of daily steps of participants by Wechat mini App	2020 June
Follow-up: Data collection of questionnaire, health examination of participants, and daily steps in one month	2020 December – 2021 February
Follow-up: Data collection of questionnaire, health examination of participants, and daily steps in one month	2021 December – 2022 February
Follow-up: Data collection of questionnaire, health examination of participants, and daily steps in one month	2022 December – 2023 February

Questionnaire

Part One: Basic Personal Information

1. Name: _____

2. Physical Examination Number: _____

3. Birthplace: City_____, Province_____

4. Present Address: Number_____, Neighborhood Committee/Village_____, Township/Street_____, District/County_____, City_____ Province_____

5. Work Address: Number_____, Neighborhood Committee/Village_____, Township/Street_____, District/County_____, City_____ Province_____

6. Except for home and office, is there any other place you are frequently present?

☐Yes ☐No If yes, how long will you spend in this place in one week? ____hours

7. ID Number: _____

8. Nationality: ☐The Han Nationality ☐National Minority: _____

9. Blood Type: _____

10. Height: _____ cm

11. Weight: _____ kg

12. Education Level:

☐Did not attend school normally ☐Primary school or below

☐Junior high school ☐High school and secondary technical school

☐Junior college ☐Undergraduate college

☐Master degree and above

13. Category of Employment:

☐Company employee ☐House ☐Student

☐Active duty soldier ☐Freelancer ☐Industrial worker

☐Self-employed people ☐Full-time driver

☐Service and sales personnel ☐Professional and technical personnel

☐Civil servant, personnel of public institutions and state-owned enterprises

☐Farmers, herdsmen and fishermen ☐Others

14. Are you currently customer of Wechat daily step calculator?

☐Yes ☐No

15. In the past week, what is your average step recorded by Wechat daily step calculator, or other step recorder? _____steps

Part Two: Family History and Personal Health Status

1. Family History (Choose the diseases which your relatives are / were diagnosed with at present / in the past from those listed below)

Are / were your parents, brothers or sisters currently diagnosed with the following diseases?

(multiple choice, put a √ under the options)

Diseases	Father	Mother	Brother	Sister
Lung cancer				
Liver cancer				
Gastric cancer				
Esophageal cancer				
Colorectal cancer				
Thyroid cancer				
Prostate cancer				
Cervical cancer				
Endometrial cancer				
Ovarian cancer				
Breast cancer				
Diabetes mellitus				
Hypertension				
Obesity				
Gout (hyperuricemia)				
Hyperlipidemia				
Asthma				
Chronic obstructive pulmonary (chronic bronchitis, emphysema)				
Stroke				
Coronary heart disease or myocardial infarction				
Osteoporosis				
Mental disease				
Other diseases				
None				

2. Personal History of Diseases

Whether the following diseases are / were diagnosed? (multiple choice)

☐Lung cancer ☐Liver cancer ☐Gastric cancer ☐Esophageal cancer

☐Colorectal cancer ☐Thyroid cancer ☐Prostate cancer ☐Cervical cancer

☐Endometrial cancer ☐Ovarian cancer ☐Breast cancer ☐Diabetes

☐Hypertension ☐Hyperlipidemia ☐Stroke ☐Asthma

☐Osteoporosis ☐Fracture ☐Mental disorders ☐Neurasthenia

☐Gout (hyperuricemia) ☐Thyroid disease (thyroiditis, nodule)

☐Chronic cholecystitis and cholelithiasis ☐Gastritis or duodenal ulcer

☐Coronary heart disease or myocardial infarction

☐Prostatic disease (hyperplasia of prostate, hypertrophy)

☐Chronic obstructive pulmonary disease (chronic bronchitis, emphysema)

☐Chronic liver disease (☐hepatitis B, ☐hepatitis C, ☐fatty liver, ☐alcoholic liver, ☐liver cirrhosis)

☐Chronic glomerulonephritis (nephritis, nephrotic syndrome, chronic renal insufficiency)

☐Chronic breast diseases (hyperplasia of mammary glands, nodules, adenosis, cysts, etc.)

☐Chronic gynecologic diseases (uterine fibroids, ovarian cysts, inflammations, etc.)

☐History of operation: (The operation name:____)

☐Other diseases ☐None of the above diseases

3. Medication History

Do you take the following medicines for a long term? (continuous use for above 6 months, and more than once per day on average)

☐Hypotensive drugs ☐Beta blockers

☐Psychotropic drugs ☐Antiarrhythmic drugs

☐Uric acid-lowering drugs	☐Hypoglycemic drugs
☐Sedative or hypnotic drugs	☐Hormone drugs
☐Chinese herbal medicines	☐Antipyretic analgesics
☐Antiplatelet drugs such as aspirin	☐Lipid-modulating drugs (lipid-lowering drugs)
☐Angiotensin-converting enzyme inhibitors	☐Anti-asthmatic drugs
☐Others	☐None

Part Three: Eating Habits and Lifestyle

1. Eating Habit

1.1. Generally speaking, how many days during a week will you eat the following food on average? (single choice)

Rice	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Noodles	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Coarse Cereals	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Meat (pigs, cattle, sheep, poultry)	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Fish or other aquatic products	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Fresh vegetable and fruit	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Milk and dairy products	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Eggs and their products	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Beans and bean products	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Dessert (pastries, candy, etc)	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Fried food	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Pickled, smoked food	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat

1.2. In the past year, did you take the following nutrients for at least one month?

(except for ginseng)

□Cod liver oil / fish oil □Ginseng (at least five times a year)

□Vitamin □Other health supplements

□Calcium / iron / zinc

1.3. Have you ever experienced severe food shortages in your life?

□Yes □No If not, please turn to question 4

1.3.1. In which year did you experience the most severe food shortage? _____

1.3.2. When you were experiencing the most severe food shortage:

1.3.2.1. Did your weight decrease significantly?

□Yes □ No If yes, it dropped by ___ kilograms

1.3.2.2. Did you suffer from edema, severe anemia and other diseases caused by food shortages such as? □Yes □ No

1.4. In the past month, how often did you eat spicy food?

□Never / almost never □1-2 days a week

□A few times, but less than once a week on average

□3-5 days a week □Every day or almost every day

1.5. How old did you begin to eat spicy food every week? ____ years old

1.6. Do you like slightly spicy food or very spicy food?

□Slightly spicy □Spicy □Very spicy

1.7. Do you order food online?

□Yes □No

1.8. How often will you order food online in one week? _____Times

1.9. What are the categories of online-ordered food you select?

□Noodles with soup □Rice □Fried noodles □Dumplings

□Sweet food, eg.cake □Drinks □Others

1.10. How often will you eat outside home (not including online order food)?
_____Times

2. Smoking

<table>
<tr><td rowspan="5">Do you smoke?
□Yes. Please answer questions 2.1, 2.2,2.5 and 2.6
□No. Please answer questions 2.7-2.8.
□Quit smoking. (have quit smoking for more than one month) Please answer questions 2.3-2.6.</td><td>2.1. You began to smoke at the age of _____.</td></tr>
<tr><td>2.2. You smoke ____ cigarettes per day on average.</td></tr>
<tr><td>2.3. You quitted smoking at the age of _____.</td></tr>
<tr><td>2.4. Before quitting smoking, you smoked _____ cigarettes per day on average.</td></tr>
<tr><td>2.5. Which type of cigarettes do you smoke at present/or did you smoke before quitting?
□Filter cigarette □Non-filter Cigarettes □Cigar
□Hand-rolled cigarette / tobacco
□Tobacco pipe / waterpipe smoking</td></tr>
<tr><td></td><td>2.6. Which organ do you suck the smoke into?</td></tr>
</table>

	□To the mouth and exhale it □To the pharynx and larynx □Deep to the lung-Have you kept the habit of sucking smoke into the lung ever since you began smoking? □Yes □No
	2.7. Have you ever been exposed to the second hand smoke? □Yes □No
	2.8. How many times have you been exposed to the second hand smoke? □Nearly everyday □4-5 days a week □1-3 days a week □＜1 day per week

3. Alcohol drinking

3.1. Do you drink alcohol? (Make the choice and fill in the blanks based on reality)

□Never □In the past (have quit drinking for more than 6 months)

□Yes (If yes, please answer questions 3.1.1-3.1.4)

3.1.1 You began to drink alcohol at the age of _____.

3.1.2 How often do you drink? (Single choice)

□Twice almost everyday □Once almost everyday □3-4 times a week

□1-2 times a week □Drink every month, but less than once a week □Seldom

3.1.3 How much do you drink each time (only fill in the blanks with the alcohol you drink commonly)?

□Beer, _____bottles/day

□Yellow wine / rice wine / fruit wine, _____grams/day

□Wine, ____grams/day

□Liquor with a high alcohol level (≥40°)，_____grams/day

□Liquor with a low alcohol level (≤40°)，_____grams/day

4. Sleeping (Make the choice and fill in the blanks based on reality)

4.1. How is the quality of your sleep in the past month?

□Very good □Good □Bad □Very bad

4.2. How long did you sleep per day on average in the past month? ___ hours

4.3. Did you need to take medicine to help you fall asleep in the past month? (medicine prescribed by the doctor or purchased by yourself)

□No □＜Once every week on average

□Once-twice every week on average □≥ 3 times every week on average

5. Physical activity

5.1. In the past year, what is your activity status during work?

□Sedentary □Standing □Activity with medium amount

□Activity with heavy work load □Retired or disabled to work

5.2. What is your average working hour in one week? _____hours

5.3. In the past your, what is your transportation way to go to work?

□Walking □Driving □Taking a bus

□Riding a bike □Work at home or the place closed to home □Others

5.4. How long is the commuting time of your work? _____min

5.5. In the past one year, what is your physical activity frequency?

□Never □1-3 times one month □1-2 times one week

□3 -5 times one week □Almost everyday

5.6. What is the exercise way you did the most frequently?

□Taichi/Walking □Fast walking □Running/or other aerobics

□Swimming □Ball game □Others(such as hiking)

5.7. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, heavy construction, or climbing up stairs as part of your work?

_____ days per week

5.8. How much time did you usually spend on one of those days doing vigorous physical activities as part of your work?

_____ hours per day，_____ minutes per day

5.9. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads as part of your work? Please do not include walking.

_____ days per week

5.10. How much time did you usually spend on one of those days doing moderate physical activities as part of your work?

_____ hours per day，_____ minutes per day

5.11. During the last 7 days, on how many days did you walk for at least 10 minutes at a time as part of your work?

_____ days per week

5.12. How much time did you usually spend on one of those days walking as part of your work?

_____ hours per day，_____ minutes per day

5.13. During the last 7 days, how much time did you usually spend sitting on a weekday?

_____ hours per day，_____ minutes per day

5.14. Did you use sport watch or app for record steps or heart rate?

□Yes □ No

If yes, the name of sport watch is_____, the name of the sport app is_____

6. Others

6.1. Are you satisfied with your current living conditions?

□Cannot be more satisfied □Basically satisfied

□Ordinary □Dissatisfied □Very dissatisfied

6.2. Did you experience the events that have a significant impact on your life in the past two years, such as those listed below?

□Marital separation/divorce □Serious trauma or car accident

□Unemployment / laid-off / retirement □Death of spouse

□Serious family diversity and conflicts □Violent attacks / rapes

□Loss of economic resources / liabilities

□Bankruptcy of self-owned business or family economic breakdown

□Death or serious diseases of other family members

□Serious natural disasters (such as drought, waterlogging, etc.)

□None

6.3. In the past year, are you under great mental stress in work and life?

□No pressure □Little pressure □Ordinary

□Great pressure □Extremely great pressure

6.4. In the past one year, is any change in your body weight?

□No □Add at least 2.5kg □Lose at least 2.5kg

6.5. In the past one year, do you using drugs or controlling diet intake in order to lose weight?

□Yes □No

6.6. Could you remember your body weight when you was at age of 25?

_____kg; □Not applicable

Signature_____

Variable category	Name of variable	Normal limits or categories	Definition of variables	Data resources
Primary outcomes	body mass index	18.5-24kg/m2	outcome	calculate from health examination information
	daily steps in one month		mediator and outcome	Wechat mini application
Secondary outcomes	fasting blood glucose (GLU)	3.6-6.1 (mmol/L)	outcome	health examination
	total cholesterol (TC)	3.1-5.7 (mmol/L)	outcome	health examination
	triglyceride (Tg)	0.4-1.73 (mmol/L)	outcome	health examination
	low density lipoprotein cholesterin (LDL-C)	2.07-3.1 (mmol/L)	outcome	health examination
	high density lipoprotein cholesterin (HDL-C)	0.9-2 (mmol/L)	outcome	health examination
	body composition	mass percentage of fat	outcome	health examination
Exposure variables	WalkScore corresponding to home address	0-100	exposure	calculate from questionnaire information
	WalkScore corresponding to workplace address	0-100	exposure	calculate from questionnaire information
Other variables	height			health examination
	weight			health examination
	age	16 - 65 years old	possible confounding	questionnaire
	gender	male；female	possible confounding	questionnaire
	job		possible confounding	questionnaire
	education	under primary school; primary school, middle school; bachelor; master and a	possible confounding	questionnaire
	smoking status	giving up; never; sometimes smoke; frequently smoke	other factors will influence outcome	questionnaire
	alcohol consumption	giving up; never; sometimes drink; frequently drink	other factors will influence outcome	questionnaire
	online food order habit	never; sometimes order; frequently order	possible confounding	questionnaire
	eating diet	more details showed in questionnnaire	other factors will influence outcome	questionnaire
	physical activity	more details showed in questionnnaire	possible confounding	questionnaire

The name of health examination	Specific name of items	Normal limits or result categories
Five items of thyroid function	Free triiodothyronine (FT3)	2.0-6.6 pmol/L
	Free thyroxine (FT4)	10.3-31.0 pmol/L(0.8~2.3ng/dL)
	Thyroid-stimulating hormone (TSH)	0.3-4.5 uIU/mL
	Total triiodothyronine (TT3)	1.8-2.9 nmol/L(115~190ng/dL)
	Total thyroxine (TT4)	65-155 nmol/L(5.0~12.0μg/dL)
12-leads electrocardiogram		N=Normal; A=abnormal
Ultrasound (splenorenal major abdominal and portal vein)		
	Liver	N=Normal; A=abnormal
	Gallbladder	N=Normal; A=abnormal
	Pancreas	N=Normal; A=abnormal
	Spleen	N=Normal; A=abnormal
	Bilateral kidneys	N=Normal; A=abnormal
	Portal vein	N=Normal; A=abnormal
Carcinoembryonic antigen (CEA)		0-5 (ng/ml)
Liver function	Albumin (Alb)	38-51 (g/L)
	Albumin/Globulin	1.2-2.5
	Gamma-glutamyl transpeptidase (GGT)	4-50 (IU/L)
	Alanine amino transferase (ALT)	0-42 (IU/L)
	Aspartate amino transferase (AST)	0-42 (IU/L)
	Alkaline Phosphatase (ALP)	34-114 (IU/L)
	Globulin (G)	25-38 (g/L)
	Total protein (TP)	66-83 (g/L)
Alpha-fetoprotein (AFP)		0-20 (ng/ml)
Urine routine	Potential of hydrogen (PH)	4.6-8.0
	Urine leukocyte (LEU)	Negative or positive
	Specific grvity (SG)	1.003-1.03
	Bilirubin (BIL)	Negative or positive
	Urobilinogen (URO)	N=Normal; A=abnormal
	Urine protein (PRO)	Negative or positive
	Urine Casts	Negative or positive
	Urine erythrocyte (ERY)	Negative or positive
	Urine pus cells	Negative or positive
	Urine colour	Negative or positive
	Uroepithelial cell (U-Epc)	Negative or positive
	Urine sugar (U-GLU)	Negative or positive
	Urine ketone (KET)	Negative or positive
	Urine nitrite (NIT)	Negative or positive
	Urine transparency	Negative or positive

	Urinary mucous silk (U-MUCS)	Negative or positive
	Creatinine (CR)	45-84 (μmol/L)
	Blood urea nitrogen (UN)	1.7-8.3 (mmol/L)
	Uric acid (UN)	155-428 (μmol/L)
	Fasting blood glucose (GLU)	3.6-6.1 (mmol/L)
	Serum cystatin c (Cys-c)	0.5-1.1 (mg/L)
Blood routine		
	white blood cell (WBC)	3.5-9.5 (10*9/L)
	Percent monocytes (MON%)	3-10 (%)
	Monocytes (MON)	0.1-0.6 (10*9/L)
	Red blood cell (RBC)	3.8-5.1 (10*12/L)
	Red blood cell distribution width (SD)	11-16 (%)
	Red blood cell distribution width (CV)	37-54 (fL)
	Hematokrit (HCT)	35-45 (%)
	Percent lymphocyte (LYMPH%)	20-50 (%)
	Lymphocyte count (LYMPH)	1.1-3.2 (10*9/L)
	Mean corpuscular volume (MCV)	82-100 (fL)
	The average RBC hemoglobin content (MCH)	27-34 (pg)
	The average RBC hemoglobin concentration (MCH	316-354 (g/L)
	mean platelet volume (MPV)	9-13 (fL)
	Basophilic cell percentage (BAS%)	0-1 (%)
	absolute basophil count (BAS)	0-0.06 (10*9/L)
	Acidophilic cell percentage (EOS%)	0.4-8 (%)
	Acidophil number (EOS)	0.02-0.52 (10*9/L)
	Hemoglobin (HGB)	115-150
	Platelet distribution width (PDW)	9-17 (%)
	blood platelet count (PLT)	125-350 (10*9/L)
	Thrombocytocrit (PCT)	N (%)
	Neutrophilic granulocyte percentage (NEU%)	40-75 (%)
	Neutrophilic granulocyte count (NEU)	1.8-6.3 (10*9/L)
Blood lipid		
	Total cholesterol (TC)	3.1-5.7 (mmol/L)
	Triglyceride (Tg)	0.4-1.73 (mmol/L)
	Low density lipoprotein cholesterin (LDL-C)	2.07-3.1 (mmol/L)
	High density lipoprotein cholesterin (HDL-C)	0.9-2 (mmol/L)
Two pairs of semi - hepatitis B		
	Hepatitis B e antibody (HBe)	Negative or positive
	Hepatitis B e antigen (HBeAg)	Negative or positive

	Hepatitis B surface antibody (HBs)	Negative or positive
	Hepatitis B surface antigen (HBsAg)	Negative or positive
	Hepatitis B core antibody (HBc)	Negative or positive
Ultrasound(bilateral mammary gland)		N=Normal; A=abnormal
Ultrasound(uterus, annex)		N=Normal; A=abnormal
Vaginal secretion examination	Trichomonad	Negative or positive
	Mycete	Negative or positive
	Cleanliness of leucorrhea	Negative or positive
Thinprep cytology test(TCT)		N=Normal; A=abnormal
Body composition		Mass percentage of fat, protein, and water

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract P2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found P2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported P3
Objectives	3	State specific objectives, including any prespecified hypotheses P3
Methods		
Study design	4	Present key elements of study design early in the paper P5-P6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection P4-P7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up P4-P5 *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed P6 *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable P4-P7
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 P6-P7
Bias	9	Describe any efforts to address potential sources of bias P6-P7
Study size	10	Explain how the study size was arrived at P6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why P7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding P7
		(*b*) Describe any methods used to examine subgroups and interactions P7
		(*c*) Explain how missing data were addressed P7
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed P7 *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses P6

Continued on next page

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
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount) P7
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
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
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias P7
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence P7
Generalisability	21	Discuss the generalisability (external validity) of the study results P7
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

*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.

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The effects of walkability on physical activity and obesity: a prospective observational study protocol

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The effects of walkability on physical activity and obesity: a prospective observational study protocol

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Abstract

Introduction

The prevalence of overweight and obesity is increasing worldwide, which could lead to a set of chronic and metabolic diseases. Physical activity is a modifiable factor for obesity, which was reported to be correlated with built environment. However, the effects of built environment on physical activity are not consistent. Walkability is a convenient way to assess built environment. We aim to prospectively explore the relationship among walkability, physical activity, and obesity in Chinese participants in Chongqing, a hilly city, and provide evidence for future urban planning.

Methods and analysis

Participants will be recruited from people who receive health examination in the Health Management Centre, the First Affiliated Hospital to Army Medical University. Exposure variables are WalkScores calculated within the areas around workplace and residential addresses of participants. The primary outcomes are body mass index (BMI) measured through health examination at baseline and follow-ups, and daily walking steps recoded by WeChat mini application for 30 days after every time of health examination. Other health-related data of the participants will also be collected. Multivariate regression analysis will be performed to examine the relationship between exposure variables and outcomes.

Ethics and dissemination

The Protocol is approved by the Ethics Committee of the First Affiliated Hospital to Army Medical University (KY201839). The results will be actively disseminated through peer-review journals and conference publications.

Strengths and limitations of this study

-This study innovatively evaluates the effects of walkability on physical activity and obesity in a hilly city prospectively.

- The daily walking steps were recorded using a novel method, WeChat mini application.

-This study combines the data collected from health examination and cellphones.

-One limitation is that WeChat mini application would fail to record daily walking steps during swimming and other physical activities without cellphones.

-The other limitation is the maximum time for data collection is 30 days after one authorization.

Introduction

The prevalence of overweight and obesity has doubled worldwide since 1980, which is currently 5% in children and 12% in adults.[1] In 2015, the number of children and adults who suffered from obesity was 107.7 million and 603.7 million, respectively.[2] High body mass index (BMI), an indicator for obesity, was identified to be a risk factor for various chronic diseases, including cardiovascular disease, diabetes, chronic kidney disease, and cancers.[2] Chinese Health and Nutrition Survey showed the rate of obesity and overweight in adults increased from 25.1% to 39.6% from 1997 to 2009.[3] The updated prevalence of overweight and obesity were reported to be 25.8% and 7.9%, respectively, in 2017.[4] It is reported that the obesity rate in Chongqing in Southwestern China is 10.3%.[5-6]

One of the modifiable risk factors of obesity and chronic diseases is physical inactivity.[7-8] Physical activity indicators are correlated with some metabolic indicators.[9] Physical inactivity is partly due to insufficient activity during leisure time and an increase in sedentary behavior during occupational and domestic activities.[10] Additionally, an increase in the use of "passive" modes of transport such as taking a car or a bus has also been associated with declining physical activity levels, which means less walking or any human powered movement in daily life.[10] Insufficient physical activity contributes to 6% of the disease burden of coronary heart disease, 7% of that of type 2 diabetes, 10% of that of breast cancer, and 10% of that of colon cancer.[11] As reported, more than 533,000 deaths and more than 1.3 million deaths could be averted annually by reducing the prevalence of physical inactivity by 10% and 25%, respectively.[11] Thus, in order to ameliorate physical inactivity, it is crucial to understand its associated factors and determinants. The factors associated with physical activity in high-income countries were reported to be age, sex, health status, self-efficacy, genetic factors, and motivation.[12] At the level of population, the factors outside health sectors have been identified to be causally related to physical inactivity, for example, urban planning, transportation system, and built environment.[12-14]

Walkability is a useful tool in the process of evaluating the effects of the built environment on physical activity.[15] However, the evidence on the associations among the built environment, walkability, physical activity, and health is inconsistent. A study published in *Nature* in 2017 with more than 700 thousand participants and 68 million days recorded revealed that higher walkability was associated with more daily walking steps, whose effect was stronger for females.[15] Porter and colleagues also indicated in a cohort study with 688 participants that as one aspect of the neighborhood environment, walkability was associated with physical activity among pregnant women.[16] Other studies from Japan and North America also supported the positive effects of built environment on physical activity.[17-19] In a middle size city Bengbu in Eastern China, researchers observed about at least 30% lower risk of cardiovascular diseases were associated with moderate to high levels of WalkScore, compared with controls with low WalkScore, in which WalkScore is a measure of walkability.[20] However, a cohort study with 1819 households investigating moving to the former Olympic athletes' village in London discovered no effect associated with this living environment change on daily walking steps, indicating that ameliorating the built environment might be insufficient to enhance physical activity.[21] A study with 161 older adult participants in Canada also showed that walkability was not associated

with physical activity volume or intensity.[22] A study in a small city in China called Yuncheng also showed no positive associations of land-use mix and walking duration.[23] In addition to these inconsistent evidence, there is no research of walkability effects on physical activity and health in China.

The factors of walkability usually include residential housing units, retail shops, public transportation, street-level movement density, the distance to behavior-related destinations.[24-29] Residential housing units are a house, apartment, group of rooms, or a single room for occupancy as a separate living unit, which could predict the population allocation in an area.[30] Retail shops are one kind of points of interest, which serve for non-residential uses and can enhance the motivation of walking.[25] Accessibility, which are represented by the street-level movement density and the distance to behavior-related destinations, as well as the proximate access to public transportation are crucial characteristics of a walkable neighborhood.[26] Some studies also take into account the population density, the street connectivity, land-use diversity, infrastructure and safety for walking, aesthetics, and crime influence.[27-29] WalkScore (www.WalkScore.com) is a user-friendly open composite walkability index. It could evaluate the walkability of a mail address or a city and is widely used in the studies investigating the relationship between walkability and health status.[15,31]

The evaluation of the walkability of a community and its effects on physical activity and health status of the residents in China could shed a light on urban design, laying a foundation for future urban planning policy and physical activity promotion interventions. Additionally, there is a gap of research on the influences of walkability on the physical activity in a hilly city. This protocol is an observational, prospective cohort study of participants who receive health examination in the First Affiliated Hospital to Army Medical University. The aim of this study is to analyze the relationships among walkability, physical activity, and obesity in the residents in Chongqing for future urban planning reference. Previous literature shows lower hilliness is associated with enhanced physical health.[32] Our research hypothesis is that high WalkScore will be associated with the decrease of BMI under the context of a hilly city. The daily walking steps and metabolic profiles will be the mediators through the effect pathway from WalkScore to BMI.

We illustrate our hypothesis of causal diagram in Supplementary Figure 1. Obesity and overweight are the primary outcomes. WalkScore is the exposure variable. Daily walking steps and metabolic profiles are the mediator from WalkScore to obesity.[9,33-34] Job and education are possible confoundings between WalkScore and daily walking steps.[35] Physical activity is possible confounding between daily walking steps and metabolic profiles.[9,36] Online food order habit is possible confounding between WalkScore and metabolic profiles. Eating habit, smoking, and alcohol consumption are other factors, which will influence metabolic profiles.[37-39]

Materials and Methods

Study design and setting

Our protocol is an observational, prospective cohort study. The location of our protocol is Chongqing, a Chinese city, with multi-commercial centres, which is characterized by a unique hilly topology with two rivers, Yangtze and Jialing.[40] A map and photos with the hilly topography of Chongqing are showed in Supplementary Figure 2. Blood samples, clinical data, addresses, and related variables are collected prospectively from participants who receive health examination in the Health Management Centre, First Affiliated Hospital to Army Medical University, Chongqing. Clinical and demographic data are recorded in the hospital's database. The daily walking steps of participants are collected by WeChat mini application. Blood samples are examined by the clinical laboratory of the hospital. The home and workplace addresses and the part of listed variables in Table 1 will be collected by a questionnaire referred to a comprehensive cohort study named China Kadoorie Biobank study.[41] Participants will be recruited from October 2019 to 2020 and followed up till 2023. The recruitment period will be extended if necessary. The recruitment process can be referred to Figure 1 and the timeline is showed in Supplementary Table 1. Moreover, we will include the participants who decided an examination appointment before health examination day if he/she meets the inclusion/exclusion criteria. We need to require this kind of participants to provide home and workplace addresses on the first visit and fill questionnaire on the health examination day.

In the baseline, the specific recruitment and data collection procedure are as follows. Stage 1: after participants signed informed consent, we collected demographic data and home/workplace addresses information in 2019 October. The recruitment time will be extended to 2020 May. Stage 2: Before or on the health examination day in 2020 March-May, we will check the inclusion/exclusion criteria and screened the participants for the first time. Stage 3: collecting questionnaire on the health examination day in 2020 March-May. Stage 4: requesting participants to install WeChat mini application and endow authorization on the health examination day in 2020 March-May. Stage 4: health examination including blood sample collection and height/weight measurement are conducted. Stage 5: daily steps in 30 days will be collected after the day of health examination. Stage 6: the inclusion/exclusion criteria will be checked secondly after data collection.

In the three times follow-ups in 2021, 2022, and 2023, the data collection procedure is similar to those in the baseline. Stage 1: collecting demographic data and updating home/workplace addresses information. Stage 2: collecting questionnaire. Stage 3: requesting participants to install WeChat mini application and endow authorization. Stage 4: health examination including blood sample collection and height/weight measurement are conducted. Stage 5: daily steps in 30 days will be collected after the day of health examination.

190 Table 1. All measured variables.

Variable category	Name of variable	Normal limits* or categories	Definition of variables**	Sources of data
Primary outcomes	Body mass index	18.5-24kg/m2	Outcome	Calculate from health examination data (height and weight)
	Daily walking steps in one month		Outcome and mediator	WeChat mini application
Secondary outcomes	Fasting blood glucose (GLU)	3.6-6.1 (mmol/L)	Outcome	Health examination
	Total cholesterol (TC)	3.1-5.7 (mmol/L)	Outcome	Health examination
	Triglyceride (Tg)	0.4-1.73 (mmol/L)	Outcome	Health examination
	Low density lipoprotein cholesterin (LDL-C)	2.07-3.1 (mmol/L)	Outcome	Health examination
	High density lipoprotein cholesterin (HDL-C)	0.9-2 (mmol/L)	Outcome	Health examination
	Body composition	Mass percentage of fat	Outcome	Health examination
Exposure variables	WalkScore corresponding to home address	0-100	Exposure	Calculate from questionnaire information
	WalkScore corresponding to workplace address	0-100	Exposure	Calculate from questionnaire information
Other variables	Height			Health examination
	Weight			Health examination
	Age	16 - 65 years old	Possible confounding	Questionnaire
	Gender	Male；female	Possible confounding	Questionnaire
	Job		Possible confounding	Questionnaire
	Education	Under primary school;	Possible confounding	Questionnaire

		primary school, middle school; bachelor; master and above		
	Smoking status	Giving up; never; sometimes smoke; frequently smoke	Other factors will influence outcome	Questionnaire
	Alcohol consumption	Giving up; never; sometimes drink; frequently drink	Other factors will influence outcome	Questionnaire
	Online food order habit	Never; sometimes order; frequently order	Possible confounding	Questionnaire
	Eating diet	Not applicable	Other factors will influence outcome	Questionnaire
	Physical activity	Not applicable	Possible confounding	Questionnaire

*"Normal limits" means in these limits, the corresponding condition is normal, otherwise it suggests there may be some health concerns or some errors.

**The definition of variables can be referred to Supplementary Figure 1.

Participants

This is an open cohort study. Participants are eligible for inclusion if they satisfy the following criteria: an age between 16 and 65, using smart phones, habitual residents in the downtown area of Chongqing.

The exclusion criteria will be: 1. participants with the symptoms or signs of cardiovascular and cerebrovascular diseases, such as chest tightness, shortness of breath, and even chest pain, especially those whose symptoms get worse when climbing stairs or walking fast; 2. participants with diagnosed heart diseases, such as coronary heart diseases, hypertensive heart diseases, valvular heart diseases, and pulmonary heart diseases, who need to exercise based on principles of cardiac rehabilitation; 3. participants with other severe complications of diabetes, such as those with vision severely affected by eye diseases, those with balancing ability affected by peripheral neuropathy, those with diabetic foot, and those with renal dysfunction; 4. participants whose movement is affected by musculoskeletal disorders, e.g. patients with musculoskeletal disorders and cardiopulmonary dysfunction; 5.participants who refuse to provide corresponding information, or are not able to complete the questionnaire and health examination (This item should also be checked in data cleaning stage); 6.participants who plan to migrate to other areas or leave for a long time (more than one year); 7.participants with secondary morbid obesity caused by congenital diseases, metabolic diseases, neurologic diseases and endocrine diseases. After checking the inclusion/exclusion criteria, the participants are planned to be recruited. Participants must be able to sign written informed consent after acknowledging the benefits and risks of this study. Participants information will be checked and the follow-ups will be traced by the health managers and nurses in the Health Management Centre.

The number of the sample size was calculated using the following formula:

$$n = \frac{\left(z_{\alpha}\sqrt{2\overline{pq}} + z_{\beta}\sqrt{p_0 q_0 + p_1 q_1}\right)^2}{\left(p_1 - p_0\right)^2}$$

The parameters used in the calculation are： p_0 (the obesity prevalence in control group) as 10.3%,[6] the supposed risk ratio (RR) between groups with high WalkScore and low WalkScore as 0.5, $\alpha = 0.05$， and $1-\beta = 0.9$. In this formula, $p_1 = p_0 * RR = 5.15\%$, $\overline{p} = (p_0+p_1)/2$, $\overline{q} = 1-\overline{p}$, $q_0 = 1-p_0$, and $q_1 = 1 - p_1$, $Z_{\alpha} = 1.96$, and $Z_{\beta} = 1.282$. Based on these parameters, the sample size in exposure group and control group should be 400, respectively. Concerning the possibility of loss of follow-up, we increased the sample size by 10% to 440 participants in each group. The final sample size is 880 in total.

Measures

The questionnaire (full version of the questionnaire is attached in Supplementary File 1) filled by

participants under nurses' guidance includes the questions of participant demographics, exposure, and lifestyle factors. The measured variables, primary outcome, and secondary outcomes, exposure variables, as well as possible confoundings are listed in Table 1. The variables in detail are showed in Supplementary File 2. The relationships among different variables are illustrated in a causal diagram in Supplementary Figure 1.

During the process of data collection, the following data were collected by the questionnaire and health examination procedure as well as WeChat mini application:

1. Primary outcomes: Body mass index (BMI), and everyday walking steps are recorded by a WeChat mini application. Every year, the daily walking steps in 30 days will be collected after health examination in the hospital. BMI was calculated by the weight in kilograms divided by the square of the height in meters. Overweight and obesity were defined as a BMI of 24–27.9 kg/m^2 and a BMI ≥ 28 kg/m^2, respectively.[4] The participants will authorize the application in order to allow the researchers in this study to obtain the daily walking steps in 30 days collected by the WeChat mini application (They only need to record walking steps of 30 days once a year).
2. Secondary outcomes: metabolic profiles by blood tests; for example, cholesterol levels and blood glucose. Body composition was measured by a machine named inbody 220, when doing the measurement in which, the participants will stand on the machine without shoes and hold the two poles of the machine for five minutes.
3. Exposure variables: Walkscores which will be calculated based on the workplace address and residential address of the participants.
4. Participant demographics: age, gender, height, marital status, and education.
5. Lifestyle factors: smoking status, alcohol consumption, online food order habit, eating diet, and physical activity
6. Identification of non-communicable diseases: e.g. hypertension, coronary artery disease, and diabetes.

Biological samples and assay methods

The blood samples are collected by nurses in the Health Management Centre in the morning. The participants should be fasting for 12 to 14 hours before health examination. A sum of 5mL blood was collected in the yellow tube with inert separating gel for cholesterol and glucose testing. A total of 2mL blood for blood routine test was stored in a purple tube with ethylenediaminetetraacetic acid (EDTA) as anticoagulant. The blood samples are analyzed by automated biochemical analyzer, with the series number of Beckman AU5811. Total cholesterol was tested by the cholesteroloxidase (CHO) enzyme method. Triglyceride was tested by the glycerol phosphate dehydrogenase and peroxidase (GPO-POD) method.

Physical examination

The physical examination included the measurement of height, body weight, blood pressure, and body component following the guidelines of the Health Management Centre. The blood pressure was evaluated by electronic sphygmomanometer (Omron, type： B-203RV III C). The machine Inbody 220 was used to analyze body component including the proportion of water, protein,

mineral salt, and fat.

WalkScore

WalkScore measures pedestrian friendliness by analyzing the distance to points of interest and the weights of points of interest. Data sources are from Google, Factual, Great Schools, Open Street Map, the U.S. Census, Localeze, and places added by the Walk Score user community.[42] The algorithm of WalkScore is not disclosed in its official website. The formula[43] of WalkScore illustrated in Tsinghua University is

$$\sum_{i=1,j=1}^{m,n} (W_i * S_{i,j} * D_{i,j}) * \frac{100}{15} .$$

W_i is the weight of one kind of amenity. Table 2 shows the weights of different amenities.

Amenity's name	Weight	Amenity's name	Weight	Amenity's name	Weight
convenience store	3	café/teahouse	2	school	1
restaurant	3	bank	1	bookstore	1
shop	2	park	1	entertainment places	1

Table 2. Weights of different amenities.

The letter of i stands for different kinds of amenities. The letter of j stands for different walking distance. $S_{i,j}$ stands for service scope of a specific amenity. $D_{i,j}$ stands for the attenuation coefficient based on distance from the calculated point to an amenity. Table 3 shows the attenuation coefficients based on the distances from the calculated point to an amenity.

Distances	Attenuation coefficients
<400 metres	1
400-800 metres	0.9
800-1200 metres	0.55
1200-1600 metres	0.25
1600-2400 metres	0.08
>2400 metres	Out of distance scope, which will not be calculated.

Table 3. Attenuation coefficients based on the distances.

The calculation of WalkScore is free, to obtain which we could type the name of calculated point into the official website/cellphone application and wait for the score (www.WalkScore.com). The limit of the score is 0-100. The WalkScore of residential address and workplace address will be calculated separately.

The following Table 4 describes the meanings of different WalkScore.

WalkScore	Description
90 - 100	Walker's Paradise: Daily errands do not require a car.
70 - 89	Very Walkable: Most errands can be accomplished on foot.
50 - 69	Somewhat Walkable: Some errands can be accomplished on foot.
25 - 49	Car-dependent: Most errands require a car.
0 - 24	Almost all errands require a car.

Table 4. Interpretations of different WalkScore.

WeChat mini application

WeChat is a cellphone application for communication used by more than a billion people.[44] The customers of it can send voice, video, photos, and text. On the basis of WeChat and its great number of users, the company of WeChat opens the resources to the public of developing different kinds of WeChat mini applications. Users could link its WeChat ID to WeChat mini application without download installment package and achieve data sharing through WeChat mini application. WeChat could also record daily step data from users' cellphones after user's agreement. Through WeChat mini application, we could extract the daily walking steps of WeChat users in one month after customer agreement. After we develop the WeChat mini application following the guideline from WeChat and publish it, the participants could open the WeChat mini application in their WeChat and signed a second consent to agree that they are willing to allow us extract daily steps on the platform of WeChat. Then, the customers' daily step information will be delivered to our datasets automatically. The obtained data will be consistently with the records in participants' cell phones.

Statistical methods

The data analysis will be conducted after data collection in 2020. The prospective analysis will be implemented in 2023. Stata (Version 14.0, Stata Corp., College Station, TX, USA) and R (Version 4.0.2) will be used for data analysis. Descriptive statistics is performed to analyze the distribution of the data. Missing data were addressed by deletion or last observation carried forward based on specific case status. Single variable analysis will be implemented to analyze the correlations between exposures, possible confoundings (i.e., online food order habit, education, job, physical activity), and outcomes. The participants will be divided into five groups by the categories of the WalkScore with regard to workplace address and residential address, respectively. The lifestyle factors and outcomes will be compared among groups. All the variables in causal diagrams will be compared between baseline and follow-ups. T-test will be used for comparing the difference of the continuous variables in two groups, and Chi-square test or Analysis of Variance (ANOVA) will be used for comparing the difference of categorial variables in different groups. Multivariate linear regression will be conducted taken BMI and daily walking steps as dependent variables, respectively, as cross-sectional analyses, after data collection in 2020. Sensitivity analysis will be

implemented by bootstrap method. With replacement from the original dataset, the bootstrap method enables estimation of the accuracy of an estimator by random sampling. Further longitudinal analyses with G estimation and inverse probability weight analysis will be conducted after data collection in 2023 in order to take into account the effects of confounders whose conditions may change over time. The first step is to determine the ranges and variations of the independent variables, which are input into our multivariate linear regression. The second step is to generate independent variables based on the Sobol sequence by R package ''randtoolbox''. The final step is to collect and process the simulation results, which can be used in sensitivity analysis through conducting multivariate linear regression.[45]

Patient and public involvement

Our study is an observational study without intervention on participants. The development of the research question and outcome measures were informed by participants' priorities, experience, and preferences on the basis of informed consents. There is no participants' involvement in the study design. We recruit participants when conducting the study, but participants would not be the conductor of the study. The results are planned to disseminate to study participants.

Ethics and dissemination

The Protocol is approved by the Ethics Committee of the First Affiliated Hospital to Army Medical University (KY201839). All the participants will receive consultation about the benefits and possible risks of the study from health managers and nurses, and endow written informed consent before enrollment. All the participants will be informed that they can withdraw from the study at any time for any reason. The withdrawal cases will be discarded and related information will be deleted from the database of the study.

The sample volume of blood for the study is 11 per participant-visit and maximum 55 for five years. The blood sampling process is part of the procedure of health examination and this study acquires the data use authority after the recruitment. The participants will be contacted and informed the results of the health examination. The researchers of this study will be responsible for implementing the study adhering to the Declaration of Helsinki.

We plan to analyze and publish study results according to the STROBE guidelines. Results will be published in international and peer-reviewed scientific journals. Negative, positive, conclusive or inconclusive results will be published.

Study Status

We collected demographic data, home addresses, and workplace addresses of participants in October 2019. We plan to check previous data and collect the data of health examination and questionnaire of participants in March to May 2020 and daily walking steps of participants by WeChat mini application in 2020 (in one month after health examination). We will continue

follow-up in 2021-2023. The follow-up will be sustained by contacting with participants and requiring health examination by phone. Currently, the daily walking steps collector of the WeChat mini application has been developed. The study was registered in Chinese Clinical Trial Registry (ChiCTR) and the registration number is ChiCTR1800017680. The date of the study in a timeline is showed in Supplementary Table 1. There will be six waves of date collection.

Discussion and potential limitations

This observational and prospective study could innovatively provide evidence of the relationship among walkability, obesity, and physical activity in China. It will also provide evidence of the influence of built environment on physical activity in a hilly city, Chongqing. We hypothesized that the walkability, physical activity, and obesity status are strongly associated with each other. The use of WeChat mini application in data collection process have a lot of advantages. Through extracting data from cellphones' records, the data collection is very convenient and cost-effective which eliminates the errors of manual typing. The participants will sign informed consents before recruitment and sign an agreement to endow WeChat mini application to collect their daily steps before the use of WeChat, in which way we could ensure the process meets the ethic requirements.

There are some limitations in the collection of physical activity. The WeChat mini application can only record the daily walking steps when the participants walk with their phone. Like other studies, activities without carrying phones such as swimming and ball games will not be recorded in the data collection procedure.[15] Moreover, more than 30 days' collection needs second authorization (the maximum data collection time is 30 days after one authorization) which is less adherent; thus the researchers could only collect the data of 30 days in one year for convenience. In order to compensate for this limitation, the participants will be recruited all year round and the researchers will ask for a second authorization of daily step collection in the follow-up visit. In terms of season, the season when we do the data collection may also influence the number of daily steps. We will consider season as a confounder in future data analysis.

Moreover, WalkScore is based on an online calculation website which has not opened the algorithm officially. Other walkability evaluation tools such as Pedestrian Environment Quality Index (PEQI) depend on the evaluation of geographic information system (GIS), the score process of which is relatively clean; however, the practice is more complex.[46-48] Thus, we decide to choose WalkScore for the exploratory study. If the results could indicate a strong relationship between walkability and obesity, we could further analyze the specific component factors such as the diversity of points of interests of walkability in following analysis.

Legends

Supplementary Figure 1. Causal diagram of measured variables.
Obesity and overweight are the primary outcomes. WalkScore is the exposure variable. The participants will be divided into five groups by the categories of the WalkScore with regard to workplace address and residential address, respectively (In this way, we decide the exposure

degree). Daily walking steps and metabolic profiles are the mediator from WalkScore to obesity. Job and education are possible confoundings between WalkScore and daily walking steps. Physical activity is possible confounding between daily walking steps and metabolic profiles. Online food order habit is possible confounding between WalkScore and metabolic profiles. Eating habit, smoking, and alcohol consumption are other factors, which will influence metabolic profiles.

Supplementary Figure 2A. Chongqing map.
It is the nine main districts of Chongqing extracted from Open Street Map. The black point shows the location of the First Affiliated Hospital to Army Medical Univerisity in Shapingba District. Shapingba District is an old town with a lot of renowned high schools and universities.

Supplementary Figure 2B. Chongqing location.
It shows the location of Chongqing relative to the other cities (Chengdu, Suining, Zigong, Jianyang, and so on). The topography of Chongqing is more hilly than that of Chengdu.

Figure 1. Flow chart of study.

Supplementary Table 1. Timeline of study conduction.

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Competing interests: All authors have completed the ICMJE uniform disclosure form at http://www.icmje.org/coi_disclosure.pdf and declare: no support from any organization for the submitted work; no financial relationships with any organization that might have an interest in the submitted work in the previous three years, no other relationships or activities that could appear to have influenced the submitted work.

Contributors: SC and YZ are joint first authors. SC contributed to study concept and design. SC wrote the first draft of the protocol manuscript. ZC supervised the process. YZ and JS revised the manuscript after feedback from all authors. YZ coordinates the conducting of this study. All authors reviewed the manuscript and approved the final version of the manuscript.

Data sharing statement: No additional data are available.

Patient consent: Consent will be obtained in the enrollment process.

Ethics approval: The Protocol is approved by the Ethics Committee of the first affiliated hospital to Army Medical University (KY201839).

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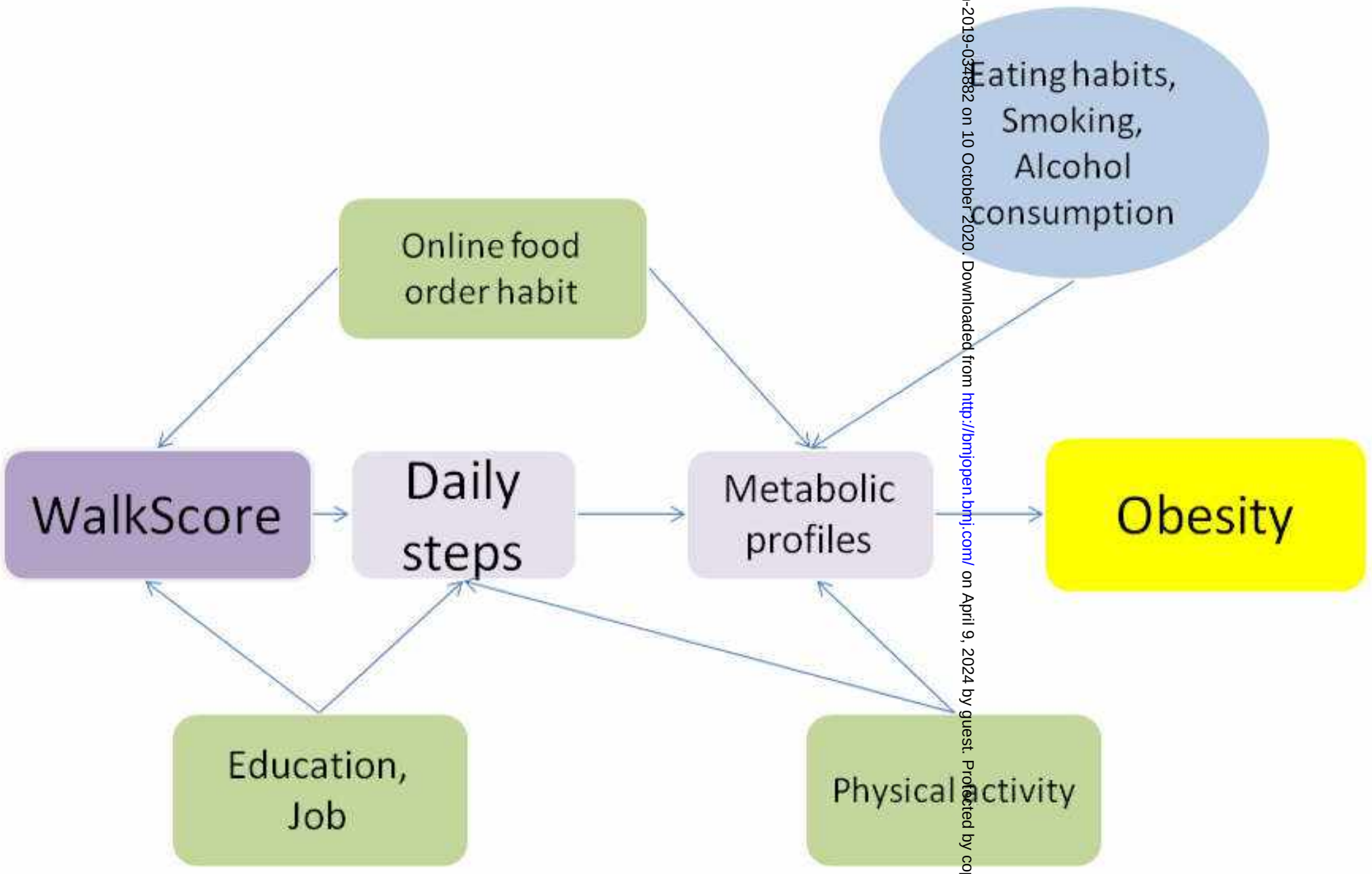
Participants who receive health examination in the Health Management Centre

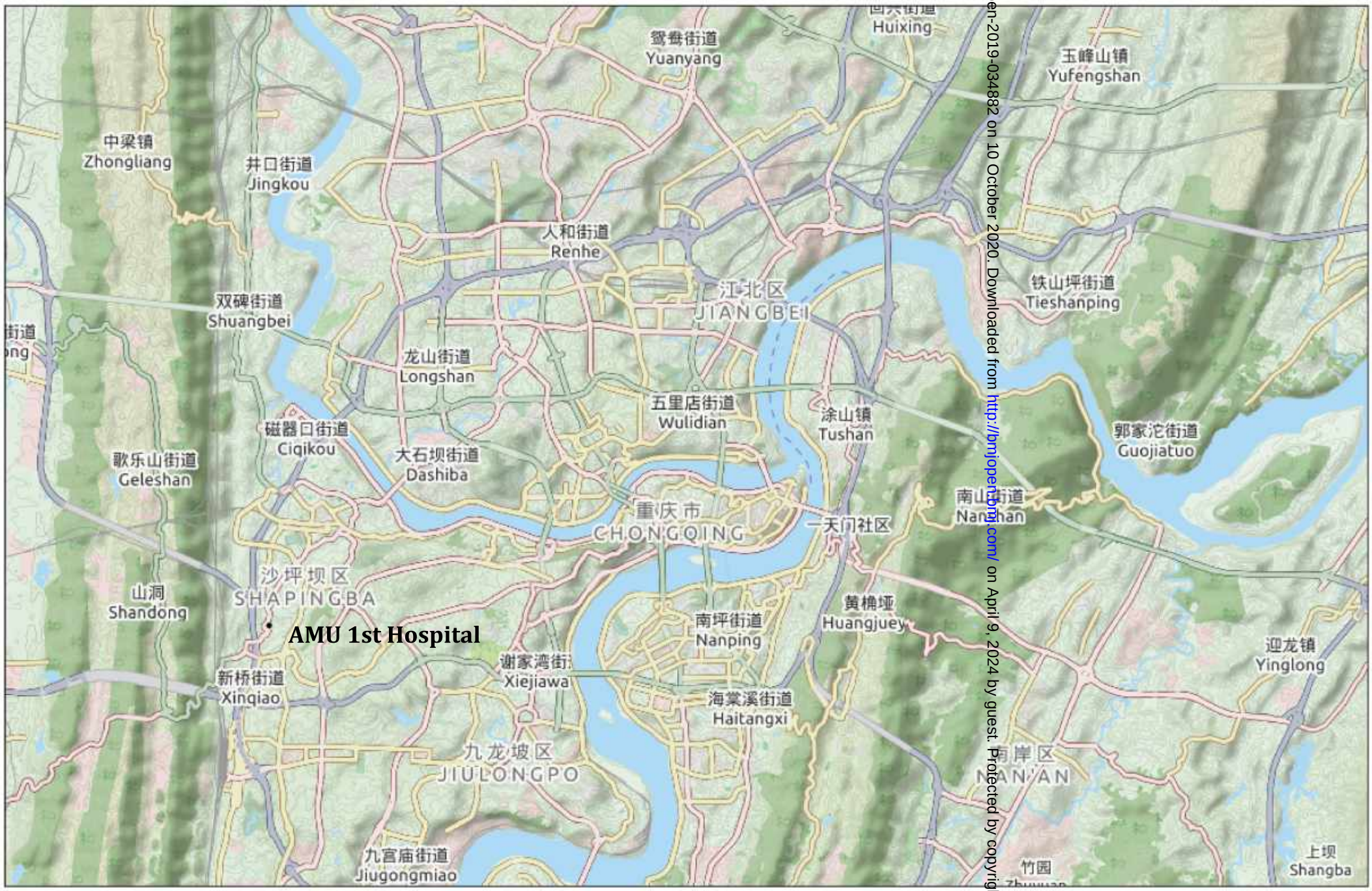
Inclusion/exclusion criteria

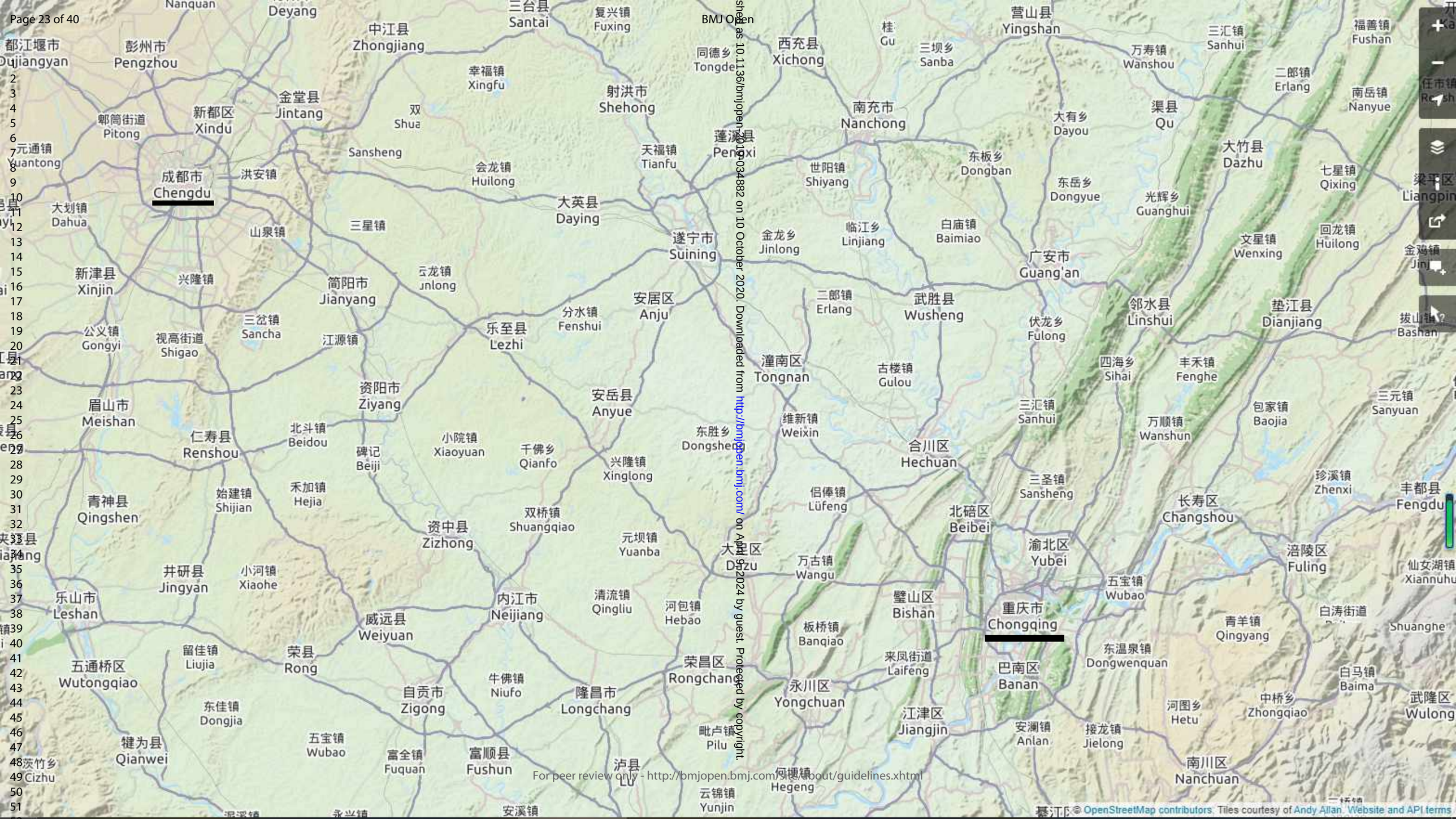
Home and workplace addresses：
Walkscore

Wechat Mini App in smartphone：
Daily steps

Health information from health examination：
BMI etc.







Supplementary Table 1. The timeline of study conduction

Approval of ethic committee	2018 July 10th
Completion of clinical registration on Chinese Clinical Trial Registry Platform	2018 August 9th
Date collection of demographic data and home/workplace addresses of participants	2019 October
Development of Wechat mini App for recording daily steps	2020 January
Previous data checking and data collection of questionnaire and health examination of participants	2020 March-May
Date collection of daily steps of participants by Wechat mini App	2020 June
Follow-up: Data collection of questionnaire, health examination of participants, and daily steps in one month	2020 December – 2021 February
Follow-up: Data collection of questionnaire, health examination of participants, and daily steps in one month	2021 December – 2022 February
Follow-up: Data collection of questionnaire, health examination of participants, and daily steps in one month	2022 December – 2023 February

Questionnaire

Part One: Basic Personal Information

1. Name: _____

2. Physical Examination Number: _____

3. Birthplace: City_____, Province_____

4. Present Address: Number_____, Neighborhood Committee/Village_____, Township/Street_____, District/County_____, City_____ Province_____

5. Work Address: Number_____, Neighborhood Committee/Village_____, Township/Street_____, District/County_____, City_____ Province_____

6. Except for home and office, is there any other place you are frequently present?

☐Yes ☐No If yes, how long will you spend in this place in one week? ____hours

7. ID Number: _____

8. Nationality: ☐The Han Nationality ☐National Minority: _____

9. Blood Type: _____

10. Height: _____ cm

11. Weight: _____ kg

12. Education Level:

☐Did not attend school normally ☐Primary school or below

☐Junior high school ☐High school and secondary technical school

☐Junior college ☐Undergraduate college

☐Master degree and above

13. Category of Employment:

☐Company employee ☐House ☐Student

☐Active duty soldier ☐Freelancer ☐Industrial worker

☐Self-employed people ☐Full-time driver

☐Service and sales personnel ☐Professional and technical personnel

☐Civil servant, personnel of public institutions and state-owned enterprises

☐Farmers, herdsmen and fishermen ☐Others

14. Are you currently customer of Wechat daily step calculator?

☐Yes ☐No

15. In the past week, what is your average step recorded by Wechat daily step calculator, or other step recorder? _____steps

Part Two: Family History and Personal Health Status

1. Family History (Choose the diseases which your relatives are / were diagnosed with at present / in the past from those listed below)

Are / were your parents, brothers or sisters currently diagnosed with the following diseases?

(multiple choice, put a √ under the options)

Diseases	Father	Mother	Brother	Sister
Lung cancer				
Liver cancer				
Gastric cancer				
Esophageal cancer				
Colorectal cancer				
Thyroid cancer				
Prostate cancer				
Cervical cancer				
Endometrial cancer				
Ovarian cancer				
Breast cancer				
Diabetes mellitus				
Hypertension				
Obesity				
Gout (hyperuricemia)				
Hyperlipidemia				
Asthma				
Chronic obstructive pulmonary (chronic bronchitis, emphysema)				
Stroke				
Coronary heart disease or myocardial infarction				
Osteoporosis				
Mental disease				
Other diseases				
None				

2. Personal History of Diseases

Whether the following diseases are / were diagnosed? (multiple choice)

☐Lung cancer ☐Liver cancer ☐Gastric cancer ☐Esophageal cancer

☐Colorectal cancer ☐Thyroid cancer ☐Prostate cancer ☐Cervical cancer

☐Endometrial cancer ☐Ovarian cancer ☐Breast cancer ☐Diabetes

☐Hypertension ☐Hyperlipidemia ☐Stroke ☐Asthma

☐Osteoporosis ☐Fracture ☐Mental disorders ☐Neurasthenia

☐Gout (hyperuricemia) ☐Thyroid disease (thyroiditis, nodule)

☐Chronic cholecystitis and cholelithiasis ☐Gastritis or duodenal ulcer

☐Coronary heart disease or myocardial infarction

☐Prostatic disease (hyperplasia of prostate, hypertrophy)

☐Chronic obstructive pulmonary disease (chronic bronchitis, emphysema)

☐Chronic liver disease (☐hepatitis B, ☐hepatitis C, ☐fatty liver, ☐alcoholic liver, ☐liver cirrhosis)

☐Chronic glomerulonephritis (nephritis, nephrotic syndrome, chronic renal insufficiency)

☐Chronic breast diseases (hyperplasia of mammary glands, nodules, adenosis, cysts, etc.)

☐Chronic gynecologic diseases (uterine fibroids, ovarian cysts, inflammations, etc.)

☐History of operation: (The operation name:____)

☐Other diseases ☐None of the above diseases

3. Medication History

Do you take the following medicines for a long term? (continuous use for above 6 months, and more than once per day on average)

☐Hypotensive drugs ☐Beta blockers

☐Psychotropic drugs ☐Antiarrhythmic drugs

☐Uric acid-lowering drugs	☐Hypoglycemic drugs
☐Sedative or hypnotic drugs	☐Hormone drugs
☐Chinese herbal medicines	☐Antipyretic analgesics
☐Antiplatelet drugs such as aspirin	☐Lipid-modulating drugs (lipid-lowering drugs)
☐Angiotensin-converting enzyme inhibitors	☐Anti-asthmatic drugs
☐Others	☐None

Part Three: Eating Habits and Lifestyle

1. Eating Habit

1.1. Generally speaking, how many days during a week will you eat the following food on average? (single choice)

Rice	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Noodles	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Coarse Cereals	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Meat (pigs, cattle, sheep, poultry)	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Fish or other aquatic products	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Fresh vegetable and fruit	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Milk and dairy products	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Eggs and their products	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Beans and bean products	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Dessert (pastries, candy, etc)	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Fried food	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat
Pickled, smoked food	□5 - 7 days	□3 - 4 days	□1 - 2 days	□<1day or never eat

1.2. In the past year, did you take the following nutrients for at least one month?

(except for ginseng)

□Cod liver oil / fish oil □Ginseng (at least five times a year)

□Vitamin □Other health supplements

□Calcium / iron / zinc

1.3. Have you ever experienced severe food shortages in your life?

□Yes □No If not, please turn to question 4

1.3.1. In which year did you experience the most severe food shortage? _____

1.3.2. When you were experiencing the most severe food shortage:

1.3.2.1. Did your weight decrease significantly?

□Yes □ No If yes, it dropped by ___ kilograms

1.3.2.2. Did you suffer from edema, severe anemia and other diseases caused by food shortages such as? □Yes □ No

1.4. In the past month, how often did you eat spicy food?

□Never / almost never □1-2 days a week

□A few times, but less than once a week on average

□3-5 days a week □Every day or almost every day

1.5. How old did you begin to eat spicy food every week? ____ years old

1.6. Do you like slightly spicy food or very spicy food?

□Slightly spicy □Spicy □Very spicy

1.7. Do you order food online?

□Yes □No

1.8. How often will you order food online in one week? _____Times

1.9. What are the categories of online-ordered food you select?

□Noodles with soup □Rice □Fried noodles □Dumplings

□Sweet food, eg.cake □Drinks □Others

1.10. How often will you eat outside home (not including online order food)?
_____Times

2. Smoking

<table>
<tr><td rowspan="5">Do you smoke?
□Yes. Please answer questions 2.1, 2.2,2.5 and 2.6
□No. Please answer questions 2.7-2.8.
□Quit smoking. (have quit smoking for more than one month) Please answer questions 2.3-2.6.</td><td>2.1. You began to smoke at the age of _____.</td></tr>
<tr><td>2.2. You smoke ____ cigarettes per day on average.</td></tr>
<tr><td>2.3. You quitted smoking at the age of _____.</td></tr>
<tr><td>2.4. Before quitting smoking, you smoked _____ cigarettes per day on average.</td></tr>
<tr><td>2.5. Which type of cigarettes do you smoke at present/or did you smoke before quitting?
□Filter cigarette □Non-filter Cigarettes □Cigar
□Hand-rolled cigarette / tobacco
□Tobacco pipe / waterpipe smoking</td></tr>
<tr><td></td><td>2.6. Which organ do you suck the smoke into?</td></tr>
</table>

	□To the mouth and exhale it □To the pharynx and larynx □Deep to the lung-Have you kept the habit of sucking smoke into the lung ever since you began smoking? □Yes □No
	2.7. Have you ever been exposed to the second hand smoke? □Yes □No
	2.8. How many times have you been exposed to the second hand smoke? □Nearly everyday □4-5 days a week □1-3 days a week □＜1 day per week

3. Alcohol drinking

3.1. Do you drink alcohol? (Make the choice and fill in the blanks based on reality)

□Never □In the past (have quit drinking for more than 6 months)

□Yes (If yes, please answer questions 3.1.1-3.1.4)

3.1.1 You began to drink alcohol at the age of _____.

3.1.2 How often do you drink? (Single choice)

□Twice almost everyday □Once almost everyday □3-4 times a week

□1-2 times a week □Drink every month, but less than once a week □Seldom

3.1.3 How much do you drink each time (only fill in the blanks with the alcohol you drink commonly)?

□Beer, _____bottles/day

□Yellow wine / rice wine / fruit wine, _____grams/day

□Wine, ____grams/day

□Liquor with a high alcohol level (≥40°)，_____grams/day

□Liquor with a low alcohol level (≤40°)，_____grams/day

4. Sleeping (Make the choice and fill in the blanks based on reality)

4.1. How is the quality of your sleep in the past month?

□Very good □Good □Bad □Very bad

4.2. How long did you sleep per day on average in the past month? ___ hours

4.3. Did you need to take medicine to help you fall asleep in the past month? (medicine prescribed by the doctor or purchased by yourself)

□No □＜Once every week on average

□Once-twice every week on average □≥ 3 times every week on average

5. Physical activity

5.1. In the past year, what is your activity status during work?

□Sedentary □Standing □Activity with medium amount

□Activity with heavy work load □Retired or disabled to work

5.2. What is your average working hour in one week? _____hours

5.3. In the past your, what is your transportation way to go to work?

□Walking □Driving □Taking a bus

□Riding a bike □Work at home or the place closed to home □Others

5.4. How long is the commuting time of your work? _____min

5.5. In the past one year, what is your physical activity frequency?

□Never □1-3 times one month □1-2 times one week

□3 -5 times one week □Almost everyday

5.6. What is the exercise way you did the most frequently?

□Taichi/Walking □Fast walking □Running/or other aerobics

□Swimming □Ball game □Others(such as hiking)

5.7. During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, heavy construction, or climbing up stairs as part of your work?

_____ days per week

5.8. How much time did you usually spend on one of those days doing vigorous physical activities as part of your work?

_____ hours per day，_____ minutes per day

5.9. During the last 7 days, on how many days did you do moderate physical activities like carrying light loads as part of your work? Please do not include walking.

_____ days per week

5.10. How much time did you usually spend on one of those days doing moderate physical activities as part of your work?

_____ hours per day，_____ minutes per day

5.11. During the last 7 days, on how many days did you walk for at least 10 minutes at a time as part of your work?

_____ days per week

5.12. How much time did you usually spend on one of those days walking as part of your work?

_____ hours per day，_____ minutes per day

5.13. During the last 7 days, how much time did you usually spend sitting on a weekday?

_____ hours per day，_____ minutes per day

5.14. Did you use sport watch or app for record steps or heart rate?

□Yes □ No

If yes, the name of sport watch is_____, the name of the sport app is_____

6. Others

6.1. Are you satisfied with your current living conditions?

□Cannot be more satisfied □Basically satisfied

□Ordinary □Dissatisfied □Very dissatisfied

6.2. Did you experience the events that have a significant impact on your life in the past two years, such as those listed below?

□Marital separation/divorce □Serious trauma or car accident

□Unemployment / laid-off / retirement □Death of spouse

□Serious family diversity and conflicts □Violent attacks / rapes

□Loss of economic resources / liabilities

□Bankruptcy of self-owned business or family economic breakdown

□Death or serious diseases of other family members

□Serious natural disasters (such as drought, waterlogging, etc.)

□None

6.3. In the past year, are you under great mental stress in work and life?

□No pressure □Little pressure □Ordinary

□Great pressure □Extremely great pressure

6.4. In the past one year, is any change in your body weight?

□No □Add at least 2.5kg □Lose at least 2.5kg

6.5. In the past one year, do you using drugs or controlling diet intake in order to lose weight?

□Yes □No

6.6. Could you remember your body weight when you was at age of 25?

_____kg; □Not applicable

Signature_____

Variable category	Name of variable	Normal limits or categories	Definition of variables	Data resources
Primary outcomes	body mass index	18.5-24kg/m2	outcome	calculate from health examination information
	daily steps in one month		mediator and outcome	Wechat mini application
Secondary outcomes	fasting blood glucose (GLU)	3.6-6.1 (mmol/L)	outcome	health examination
	total cholesterol (TC)	3.1-5.7 (mmol/L)	outcome	health examination
	triglyceride (Tg)	0.4-1.73 (mmol/L)	outcome	health examination
	low density lipoprotein cholesterin (LDL-C)	2.07-3.1 (mmol/L)	outcome	health examination
	high density lipoprotein cholesterin (HDL-C)	0.9-2 (mmol/L)	outcome	health examination
	body composition	mass percentage of fat	outcome	health examination
Exposure variables	WalkScore corresponding to home address	0-100	exposure	calculate from questionnaire information
	WalkScore corresponding to workplace address	0-100	exposure	calculate from questionnaire information
Other variables	height			health examination
	weight			health examination
	age	16 - 65 years old	possible confounding	questionnaire
	gender	male；female	possible confounding	questionnaire
	job		possible confounding	questionnaire
	education	under primary school; primary school, middle school; bachelor; master and a	possible confounding	questionnaire
	smoking status	giving up; never; sometimes smoke; frequently smoke	other factors will influence outcome	questionnaire
	alcohol consumption	giving up; never; sometimes drink; frequently drink	other factors will influence outcome	questionnaire
	online food order habit	never; sometimes order; frequently order	possible confounding	questionnaire
	eating diet	more details showed in questionnnaire	other factors will influence outcome	questionnaire
	physical activity	more details showed in questionnnaire	possible confounding	questionnaire

The name of health examination	Specific name of items	Normal limits or result categories
Five items of thyroid function	Free triiodothyronine (FT3)	2.0-6.6 pmol/L
	Free thyroxine (FT4)	10.3-31.0 pmol/L(0.8~2.3ng/dL)
	Thyroid-stimulating hormone (TSH)	0.3-4.5 uIU/mL
	Total triiodothyronine (TT3)	1.8-2.9 nmol/L(115~190ng/dL)
	Total thyroxine (TT4)	65-155 nmol/L(5.0~12.0μg/dL)
12-leads electrocardiogram		N=Normal; A=abnormal
Ultrasound (splenorenal major abdominal and portal vein)		
	Liver	N=Normal; A=abnormal
	Gallbladder	N=Normal; A=abnormal
	Pancreas	N=Normal; A=abnormal
	Spleen	N=Normal; A=abnormal
	Bilateral kidneys	N=Normal; A=abnormal
	Portal vein	N=Normal; A=abnormal
Carcinoembryonic antigen (CEA)		0-5 (ng/ml)
Liver function	Albumin (Alb)	38-51 (g/L)
	Albumin/Globulin	1.2-2.5
	Gamma-glutamyl transpeptidase (GGT)	4-50 (IU/L)
	Alanine amino transferase (ALT)	0-42 (IU/L)
	Aspartate amino transferase (AST)	0-42 (IU/L)
	Alkaline Phosphatase (ALP)	34-114 (IU/L)
	Globulin (G)	25-38 (g/L)
	Total protein (TP)	66-83 (g/L)
Alpha-fetoprotein (AFP)		0-20 (ng/ml)
Urine routine	Potential of hydrogen (PH)	4.6-8.0
	Urine leukocyte (LEU)	Negative or positive
	Specific grvity (SG)	1.003-1.03
	Bilirubin (BIL)	Negative or positive
	Urobilinogen (URO)	N=Normal; A=abnormal
	Urine protein (PRO)	Negative or positive
	Urine Casts	Negative or positive
	Urine erythrocyte (ERY)	Negative or positive
	Urine pus cells	Negative or positive
	Urine colour	Negative or positive
	Uroepithelial cell (U-Epc)	Negative or positive
	Urine sugar (U-GLU)	Negative or positive
	Urine ketone (KET)	Negative or positive
	Urine nitrite (NIT)	Negative or positive
	Urine transparency	Negative or positive

	Urinary mucous silk (U-MUCS)	Negative or positive
	Creatinine (CR)	45-84 (μmol/L)
	Blood urea nitrogen (UN)	1.7-8.3 (mmol/L)
	Uric acid (UN)	155-428 (μmol/L)
	Fasting blood glucose (GLU)	3.6-6.1 (mmol/L)
	Serum cystatin c (Cys-c)	0.5-1.1 (mg/L)
Blood routine		
	white blood cell (WBC)	3.5-9.5 (10*9/L)
	Percent monocytes (MON%)	3-10 (%)
	Monocytes (MON)	0.1-0.6 (10*9/L)
	Red blood cell (RBC)	3.8-5.1 (10*12/L)
	Red blood cell distribution width (SD)	11-16 (%)
	Red blood cell distribution width (CV)	37-54 (fL)
	Hematokrit (HCT)	35-45 (%)
	Percent lymphocyte (LYMPH%)	20-50 (%)
	Lymphocyte count (LYMPH)	1.1-3.2 (10*9/L)
	Mean corpuscular volume (MCV)	82-100 (fL)
	The average RBC hemoglobin content (MCH)	27-34 (pg)
	The average RBC hemoglobin concentration (MCH	316-354 (g/L)
	mean platelet volume (MPV)	9-13 (fL)
	Basophilic cell percentage (BAS%)	0-1 (%)
	absolute basophil count (BAS)	0-0.06 (10*9/L)
	Acidophilic cell percentage (EOS%)	0.4-8 (%)
	Acidophil number (EOS)	0.02-0.52 (10*9/L)
	Hemoglobin (HGB)	115-150
	Platelet distribution width (PDW)	9-17 (%)
	blood platelet count (PLT)	125-350 (10*9/L)
	Thrombocytocrit (PCT)	N (%)
	Neutrophilic granulocyte percentage (NEU%)	40-75 (%)
	Neutrophilic granulocyte count (NEU)	1.8-6.3 (10*9/L)
Blood lipid		
	Total cholesterol (TC)	3.1-5.7 (mmol/L)
	Triglyceride (Tg)	0.4-1.73 (mmol/L)
	Low density lipoprotein cholesterin (LDL-C)	2.07-3.1 (mmol/L)
	High density lipoprotein cholesterin (HDL-C)	0.9-2 (mmol/L)
Two pairs of semi - hepatitis B		
	Hepatitis B e antibody (HBe)	Negative or positive
	Hepatitis B e antigen (HBeAg)	Negative or positive

	Hepatitis B surface antibody (HBs)	Negative or positive
	Hepatitis B surface antigen (HBsAg)	Negative or positive
	Hepatitis B core antibody (HBc)	Negative or positive
Ultrasound(bilateral mammary gland)		N=Normal; A=abnormal
Ultrasound(uterus, annex)		N=Normal; A=abnormal
Vaginal secretion examination	Trichomonad	Negative or positive
	Mycete	Negative or positive
	Cleanliness of leucorrhea	Negative or positive
Thinprep cytology test(TCT)		N=Normal; A=abnormal
Body composition		Mass percentage of fat, protein, and water

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract P2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found P2
Introduction		
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported P3
Objectives	3	State specific objectives, including any prespecified hypotheses P3
Methods		
Study design	4	Present key elements of study design early in the paper P5-P6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection P4-P7
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up P4-P5 *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed P6 *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable P4-P7
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 P6-P7
Bias	9	Describe any efforts to address potential sources of bias P6-P7
Study size	10	Explain how the study size was arrived at P6
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why P7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding P7
		(*b*) Describe any methods used to examine subgroups and interactions P7
		(*c*) Explain how missing data were addressed P7
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed P7 *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy
		(*e*) Describe any sensitivity analyses P6

Continued on next page

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
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram Figure 1
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount) P7
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time
		Case-control study—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
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
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	Summarise key results with reference to study objectives
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias P7
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence P7
Generalisability	21	Discuss the generalisability (external validity) of the study results P7
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

*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.