Life's Essential 8 Score and Risk of Hypertension in Agricultural and Pastoral Populations of Altay Region, Xinjiang: A Cross-Sectional Study Postprint

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Abstract

Background Hypertension is a major cardiovascular disease. The Life's Essential 8 (LE8) score, a recently proposed cardiovascular health assessment indicator, and its relationship with the risk of hypertension remains unclear.

Objective To investigate the relationship between LE8 score and the risk of hypertension among the agricultural and pastoral population in the Altay region of Xinjiang.

Methods From October to November 2023, 27 natural villages were selected in the Altay region using probability proportional to size (PPS) systematic sampling. Residents meeting the study requirements in the selected villages were recruited for questionnaire surveys, physical examinations, and laboratory indicator testing. The LE8 score includes 4 health behaviors (diet, physical activity, nicotine exposure, sleep) and 4 health factors (BMI, blood lipids, blood glucose, blood pressure). This study calculated the LE8 score using the remaining 7 components excluding blood pressure. The LE8 score, health behavior and health factor subscale scores, and the 7 component scores were each divided into 3 groups: low-score group (0–49 points), medium-score group (50–79 points), and high-score group (80–100 points). Restricted cubic spline plots were used to depict the dose-response curve between LE8 score and hypertension prevalence, and logistic regression models were employed to analyze the effect of LE8 score on hypertension prevalence.

Results This study included a total of 2,872 residents, among whom 1,540 hypertensive patients were identified, with a crude hypertension prevalence of 53.62% and a standardized prevalence of 34.64%. Specifically, the hypertension prevalence was 61.13% (766/1,253) in males and 47.81% (774/1,619) in females, with

males having a higher prevalence than females (P<0.05). There was a statistically significant difference in LE8 scores between residents with and without hypertension (P<0.05). After adjusting for confounding factors, compared with the low-score group, the medium-score and high-score groups of LE8 score and health factor score showed reduced risk of hypertension (P<0.05), with each 10-point increase associated with a 24.3% and 41.8% reduction in hypertension risk, respectively (P<0.05). There was a significant non-linear relationship between LE8 score and hypertension risk (Pnon-linear=0.010), while the relationship between health factor score and hypertension was linear (Pnon-linear=0.637). No significant association was found between health behavior score and hypertension (P>0.05). The high-score groups of BMI, blood glucose level, and physical activity score had lower hypertension risk than the low-score groups (P<0.05). There was an interaction between LE8 score and age in hypertension prevalence (Pinteraction<0.05), with the effect of LE8 score on reducing hypertension risk being more pronounced in individuals over 50 years old (P<0.05).

Conclusion LE8 score is non-linearly associated with the risk of hypertension, and maintaining a higher LE8 score can reduce the burden of hypertension.

Full Text

Association between Life's Essential 8 Score and Hypertension Risk: A Cross-Sectional Study in the Rural and Pastoral Population of Altay Prefecture, Xinjiang

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Abstract

Background: Hypertension is a major cardiovascular disease. The relationship between Life's Essential 8 (LE8) score, a newly developed cardiovascular health metric, and hypertension risk remains unclear. **Objective:** This study aimed to investigate the association between LE8 score and hypertension risk in the rural

and pastoral population of Altay Prefecture, Xinjiang. **Methods:** From October to November 2023, 27 natural villages were selected in Altay Prefecture using Proportionate to Population Size (PPS) systematic sampling. Eligible residents in the included natural villages were recruited for questionnaire surveys, physical examinations, and laboratory index tests. The LE8 score includes 4 health behaviors (diet, physical activity, nicotine exposure, sleep) and 4 health factors (BMI, blood lipids, blood glucose, blood pressure). In this study, the LE8 score was calculated based on the remaining 7 components excluding blood pressure. The LE8 score, subscales and components were divided into low group (0-49 points), medium group (50-79 points) and high group (80-100 points) according to their scores. A restrictive cubic spline plot was used to plot the dose-response curves of LE8, health factors and health behavior scores and hypertension. A multivariate logistic regression model was used to analyze its effect on the prevalence of hypertension. **Results:** A total of 2,872 study subjects were included in this study. Among the study subjects, 1,540 patients with hypertension were detected, yielding a crude prevalence of 53.62% and an age-standardized prevalence of 34.64%. The prevalence of hypertension was 61.13% in men (766/1,253) and 47.81% (774/1,619) in women, and the prevalence of hypertension in men was higher than that in women ($P<0.05$). In terms of LE8 score, the difference between the hypertensive group and the normal blood pressure group was statistically significant ($P<0.05$). After adjusting for confounders, the intermediate and high LE8 score groups had a lower risk of hypertension compared with the low score group ($P<0.05$). For every 10-point increase in LE8 score, the risk of hypertension decreased by 24.3% and 41.8%, respectively. A significant nonlinear relationship was observed between LE8 scores and hypertension (P for non-linear=0.010), while a linear relationship was found between health factor scores and hypertension (P for non-linear=0.637). No significant association was observed between health behavior scores and hypertension. Participants with higher BMI, blood glucose, and physical activity scores had a significantly lower risk of hypertension compared to the low-score group ($P<0.05$). An interaction between LE8 scores and age was detected (P for interaction =0.006), with a stronger effect of LE8 scores on reducing hypertension risk in individuals aged $\geq$ 50 years. **Conclusion:** LE8 scores are non-linearly associated with hypertension risk. Maintaining higher LE8 scores can reduce the burden of hypertension, particularly in individuals aged $\geq$ 50 years.

Keywords: Life's Essential 8 score; Hypertension; Rural and pastoral population; Health behaviors; Health factors; Cross-sectional study

Introduction

Hypertension is a common cardiovascular disease that can lead to heart disease, stroke, heart failure, kidney damage, and premature death. Recent WHO data show that over the past 30 years, the number of hypertensive patients aged 30-79 has increased from 650 million to 1.28 billion cases, making hypertension

prevention and control a critical global public health issue. Controllable risk factors for hypertension include unhealthy diet, overweight, physical inactivity, smoking, alcohol consumption, and insufficient sleep. Early prevention and control of these risk factors can effectively delay the onset and progression of hypertension.

In 2022, the American Heart Association (AHA) introduced the "Life's Essential 8" (LE8) cardiovascular health evaluation system, building upon the previous "Life's Simple 7" (LS7). The LE8 framework includes diet, physical activity, nicotine exposure, sleep, BMI, blood pressure, blood glucose, and blood lipids, aiming to provide a more comprehensive assessment and quantification of individual cardiovascular health. Previous studies have demonstrated a significant inverse correlation between LE8 score and cardiovascular disease risk, where higher LE8 scores are associated with lower cardiovascular disease risk. However, evidence regarding the relationship between hypertension and LE8 score in northern rural areas remains limited.

This study utilizes baseline data from a natural population cohort of cardiovascular disease in Xinjiang to explore the potential relationship between LE8 score and hypertension prevalence in the rural and pastoral population of Altay Prefecture, Xinjiang, with the aim of providing evidence for improving local cardiovascular disease prevention and control.

Methods

1.1 Study Population From October to November 2023, 27 natural villages were selected from 463 permanent natural villages in Altay Prefecture using Proportionate to Population Size (PPS) systematic sampling. Eligible residents in the selected villages were recruited through health education campaigns and village doctor referrals. Inclusion criteria were: (1) permanent residents of Altay Prefecture (continuous residence for at least 6 months); (2) age $\geq$ 30 years; (3) voluntary participation with signed informed consent. Exclusion criteria were: (1) severe metabolic diseases; (2) malignant tumors; (3) pregnant or lactating women. The study protocol was approved by the Ethics Committee of the First Affiliated Hospital of Xinjiang Medical University (Approval No.: K202001-06), and all participants provided informed consent.

1.2 Data Collection Methods

1.2.1 Questionnaire Survey Trained interviewers conducted face-to-face surveys using standardized questionnaires covering: (1) demographic characteristics including age, gender, education level, marital status, and annual household income; (2) health status such as chronic disease history and medication use; (3) health-related lifestyle factors including alcohol consumption, diet, physical activity, smoking, and sleep.

1.2.2 Physical Examination Professional staff performed physical examinations. After removing outer clothing and heavy items, participants' weight (precision 0.1 kg) and height (precision 0.1 cm) were measured to calculate BMI.

1.2.3 Laboratory Indicators Professional nurses collected venous blood samples after at least 8 hours of fasting. Samples were immediately transported at 4°C to the Clinical Laboratory Center of Xinjiang Uygur Autonomous Region People's Hospital. An automatic biochemical analyzer (cobas c311, Roche, Switzerland) was used to measure fasting blood glucose (FBG), total cholesterol (TC), high-density lipoprotein cholesterol (HDL-C), and other indicators.

1.3 LE8 Scoring Method The LE8 score comprises 4 health behaviors (diet, physical activity, nicotine exposure, sleep) and 4 health factors (BMI, blood lipids, blood glucose, blood pressure), assessed using algorithms developed by the AHA with component definitions and scoring adapted for local context. In this study, the health behavior score was calculated as the average of the 4 health behavior components, the health factor score as the average of BMI, blood lipids, and blood glucose scores, and the LE8 score as the average of the 7 components excluding blood pressure.

All scores (LE8, health behavior, health factor, and individual component scores) ranged from 0-100 points and were categorized into three groups: low (0-49 points), medium (50-79 points), and high (80-100 points). The diet score was adapted from the AHA's DASH (Dietary Approaches to Stop Hypertension) score, incorporating definitions from the Kailuan Study and China-PAR (Prediction for ASCVD Risk in China) study, with modifications for local dietary patterns. BMI criteria were adjusted for Chinese populations. Blood lipids were measured using non-HDL cholesterol. Blood glucose scoring was based on self-reported diabetes history and FBG levels. Blood pressure scoring referenced systolic and diastolic levels. Detailed definitions and quantification are provided in .

1.4 Hypertension Definition Blood pressure was measured using an automatic digital sphygmomanometer (HEM7136, Omron, Japan). Hypertension was defined according to the Chinese Hypertension Prevention and Treatment Guidelines (2023 Edition) as systolic blood pressure $\geq$ 140 mmHg (1 mmHg=0.133 kPa), or diastolic blood pressure $\geq$ 90 mmHg, or self-reported use of antihypertensive medication within the past 2 weeks.

1.5 Statistical Methods Data analysis was performed using Stata 17.0 and R Studio 4.4.0. Normally distributed continuous variables were expressed as mean $\pm$ standard deviation ($\bar{x}\pm s$) and compared using independent samples t-tests. Categorical variables were expressed as percentages and compared using ^{2} tests. Missing data (missing rate <1%) were imputed using multiple imputation. Logistic regression models were used to analyze the effect of LE8 score,

health behavior and health factor scores, and component scores on hypertension prevalence. Restricted cubic spline plots were used to examine dose-response relationships and potential associations between LE8, health factor, and health behavior scores and hypertension. Statistical significance was set at P<0.05.

Results

2.1 Basic Characteristics and LE8 Scores of Residents A total of 2,966 residents were initially enrolled, with 94 excluded due to missing hypertension diagnosis data, leaving 2,872 residents for analysis. The mean age was (50.1$±$10.5) years; 1,253 (43.63%) were male and 1,619 (56.37%) were female. Education level was high school or above for 767 residents (26.71%) and below high school for 2,105 (73.29%). Marital status was married for 2,617 (91.12%) and divorced/other for 255 (8.88%). Annual household income was <60,000 yuan for 1,888 (65.74%) and $ $60,000 yuan for 984 (34.26%). Alcohol consumption was reported by 694 (24.16%), while 2,178 (75.84%) never drank or had other drinking patterns. LE8 scores were low for 252 (8.77%), medium for 2,248 (78.27%), and high for 372 (12.95%). Significant differences between genders were observed in age, education level, marital status, drinking status, and LE8 scores (P<0.05), as shown in .

2.2 Hypertension Prevalence Among Residents Among the 2,872 residents, 1,540 hypertensive patients were identified, yielding a crude prevalence of 53.62% and an age-standardized prevalence of 34.64%. The prevalence was 61.13% (766/1,253) in men and 47.81% (774/1,619) in women, with men having significantly higher prevalence than women (^{2}=50.44, P<0.05).

2.3 Comparison of Characteristics and LE8 Scores by Hypertension Status Significant differences between hypertensive and non-hypertensive residents were found in age, gender, education level, and marital status (P<0.05), but not in annual household income or drinking status (P>0.05), as shown in . Significant differences were also observed in mean LE8 scores, health behavior and health factor scores, and component scores between groups (P<0.05), as shown in . The distribution of LE8, health behavior, and health factor score categories also differed significantly between groups (P<0.05), as shown in .

2.4 Logistic Regression Analysis of LE8 Score Effects on Hypertension Using hypertension status as the dependent variable (0=no, 1=yes) and LE8 score group, health behavior score group, and health factor score group as independent variables, logistic regression analysis revealed: (1) Without adjustment, all three score groups were significant factors (P<0.05), with medium and high groups showing lower risk than low groups (OR<1.000, P<0.05); (2) After adjusting for age and gender, LE8 and health factor score groups remained significant (P<0.05); (3) After further adjusting for education, marital status,

annual household income, and drinking status, LE8 and health factor score groups remained significant predictors (P<0.05), as shown in . Additionally, each 10-point increase in LE8 and health factor scores reduced hypertension risk by 24.3% and 41.8%, respectively, as shown in and .

2.5 Dose-Response Relationship Between LE8 Score and Hypertension Restricted cubic spline analysis revealed a significant non-linear association between LE8 scores and hypertension (P overall<0.001, P non-linear=0.010), while health factor scores showed a linear relationship (P overall<0.001, P non-linear=0.637). Hypertension risk decreased markedly with increasing LE8 and health factor scores, with risk thresholds at 67 points and 63 points (OR=1.000), respectively, beyond which risk gradually declined. However, no significant association was found between health behavior scores and hypertension risk after multivariable adjustment ([FIGURE:1]).

2.6 Effects of Individual LE8 Components on Hypertension Logistic regression analysis with hypertension status as the dependent variable and individual LE8 component score groups as independent variables showed: (1) Without adjustment, high physical activity, BMI, and blood glucose score groups had lower hypertension risk than low groups, with significant downward trends as physical activity increased, BMI decreased, and blood glucose decreased (P trend<0.05); (2) After full adjustment, the high physical activity group (>120 min/week) had 22.1% lower risk than the low group (<60 min/week) (P<0.05); the high blood glucose group (no diabetes and FBG<5.6 mmol/L) had 49.4% lower risk than the low group (diabetes and FBG$ 6.9$mmol/L)(P < 0.05); $medium(23.0\ BMI <$ $30.0kg/m^{\{2\})and high BMI groups(BMI < 23.0kg/m^{\{2\})had significantly lower risk than the low group(BMI\ 30.0kg/m^{\{2\})}}}$ (P<0.05). BMI and blood glucose scores showed dose-dependent risk reduction (P trend<0.05), while diet, nicotine exposure, sleep, and blood lipid scores were not significantly associated with hypertension risk (P trend>0.05), as shown in .

Stratified analysis across gender, age, education, marital status, annual household income, and drinking status showed consistent protective effects of LE8 scores (all P<0.05). A significant interaction between LE8 score and age was detected (P interaction<0.05), with stronger protective effects observed in individuals aged >50 years ([FIGURE:2]).

Discussion

Data from the 2023 China Cardiovascular Health and Disease Report indicate that hypertension accounts for approximately 74.24% of cardiovascular diseases, representing a major public health threat. This study examined the relationship between LE8 score and hypertension in Xinjiang's rural and pastoral population aged over 30 years. The crude hypertension prevalence of 53.62% and

standardized prevalence of 34.64% were substantially higher than previously reported rates for Xinjiang (23.16%) and national (31.4%) and US adult averages (30.1%). This elevated prevalence may be attributed to genetic factors, high-oil/high-salt dietary patterns, physical inactivity, and the unique high-altitude hypoxic environment.

Our findings demonstrate that higher LE8 scores are associated with reduced hypertension risk, with each 10-point increase reducing risk by 24.3%. This aligns with REGARDS study results showing higher LS7 scores reduced hypertension risk in Black and White adults. A Chinese cohort study of 52,990 workers also found a non-linear association between LE8 and hypertension, which our results support. Similar non-linear trends have been observed between LE8 scores and all-cause mortality, cardiovascular mortality, and non-alcoholic fatty liver disease. We further identified a linear dose-response relationship between health factor scores and hypertension, a novel finding not previously reported.

The study population's mean LE8 score was 66.38, with most individuals having moderate cardiovascular health and only 12.95% achieving high scores. This indicates suboptimal cardiovascular health status, placing this population at high CVD risk. Diet and BMI scores were particularly low, consistent with domestic studies and likely reflecting unhealthy dietary patterns, lifestyle factors, limited health awareness, and geographic and healthcare resource constraints. Among components, physical activity, BMI, and blood glucose showed the strongest effects, with significant risk reduction when physical activity exceeded 120 min/week, BMI was <23.0 kg/m^2, and fasting glucose was <5.6 mmol/L. These protective effects are well-established in literature and confirmed by our findings.

Although sleep health has been identified as an important hypertension risk factor, we found no significant associations between diet, smoking, sleep, or lipid scores and hypertension risk, contrasting with previous research. Possible explanations include limited dietary components assessed, low smoking prevalence, and unmeasured confounders. The significant interaction between LE8 score and age suggests greater protective effects in middle-aged and older adults, emphasizing the importance of lifestyle management in these groups.

This study has several limitations. First, the cross-sectional design precludes causal inference, requiring longitudinal studies to validate causal relationships. Second, LE8 components relied on self-reported data, potentially introducing information bias, particularly for health behaviors influenced by subjective perception and social desirability. Third, despite adjusting for multiple confounders, residual confounding cannot be excluded. Future intervention studies should examine the practical impact of LE8 components on hypertension.

In conclusion, higher LE8 and health factor scores are associated with reduced hypertension risk in rural and pastoral populations, with BMI, blood glucose, and physical activity showing the strongest effects. LE8 score may serve as a brief screening tool for hypertension in high-risk regions, facilitating early

identification and intervention to reduce disease burden.

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Author Contributions

Yufei Chen: Study design, data collection and analysis, manuscript drafting and revision. Qian Zhao: Study design assistance, field data collection, partial data analysis, manuscript revision suggestions. Xieyire Hamulati: Statistical analysis, results interpretation, methodology and discussion writing support. Liting Cai: Data validation, manuscript section writing. Xiaomei Li: Data quality control, methods and discussion refinement. Yining Yang: Theoretical and technical guidance, study framework development, manuscript review and critical revision. Fen Liu: Overall study supervision and manuscript guidance, quality oversight, final approval.

Conflicts of Interest: None declared.

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Figures

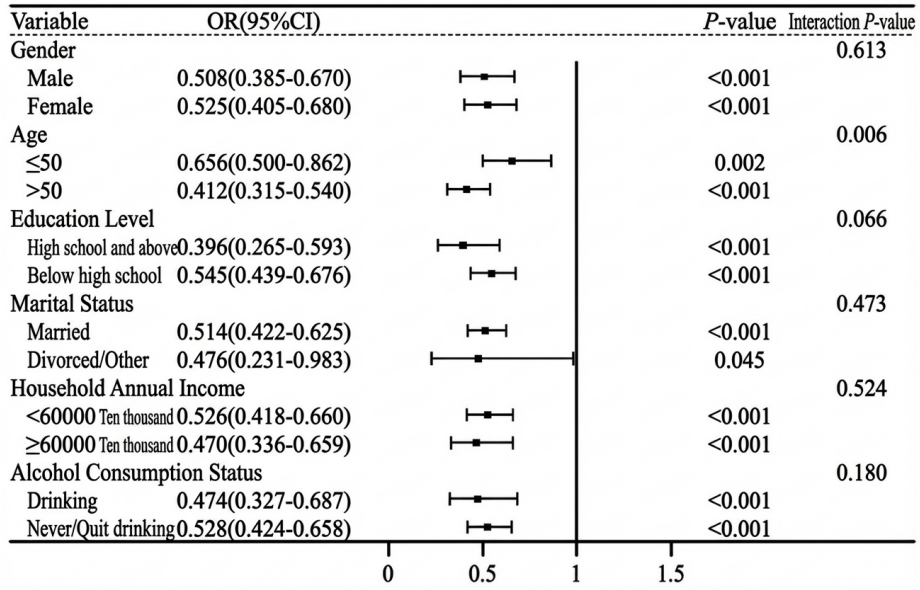

Figure 1: Figure 4