

健康な食生活と運動の知識が 実際の食生活に与える相互作用： 中国における高血圧検診を用いた 非連続回帰デザイン

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はじめに

- 生活習慣病は、先進国だけでなく、移行経済や途上国でも増加している。生活習慣病の増加は医療費を増加させる要因であり、その予防が多くの国で注目され始めている。
- 中国でも生活習慣病は急増しており、1982年には死亡原因の65%を占めていたが、2005年には80%を占めるまでになった。また、WHO(2005)の予測値によると、2000年から2015年の間、中国における生活習慣病が原因の医療費は5億6千万米ドル(約670億円)に達している。
- そのため、中国政府にとって、生活習慣病の予防は重要な政策課題の一つになっている。

はじめに

- 本論文は、生活習慣病の中でも高血圧に注目し、「健康な食生活と運動の知識」が高血圧予防のために果たす役割について考察する。
- 特に、「健康な食生活の知識」と「健康な運動の知識」が実際の食生活に与える相互作用に注目する。
- 先行研究では、「健康な食生活の知識（DK）」と「健康な運動の知識（ExK）」の効果はお互いに干渉しない（独立している）と仮定されている。
DK↑ + ExK↑ → 食生活改善 + 運動促進?
- 本論文では、この仮定に疑問を呈し、「健康な食生活の知識」と「健康な運動の知識」の相互作用について実証する。

Identification strategy

- We investigate the causal relationships between dietary/exercise knowledge, diet and exercise amount, and hypertension diagnosis.
- A key empirical challenge to estimate the causal relationships is potential bias due to omitted variables and/or reverse causality.
 - Individuals' dietary/exercise knowledge level may correlate with some unobservables that affect their food consumption and exercise amount (e.g., self-control).
 - Current blood pressures would depend on the past eating and exercise behaviors.

Identification strategy

- We use a hypertension diagnosis as a sudden shock that may affect people's eating and exercise behaviors.
- In the survey, people were mechanically diagnosed with hypertension if one's systolic blood pressure (SBP) $\geq 140\text{mmHg}$.
- Note that blood pressure fluctuates over time, and it is impossible to exactly control it at a specific time point (i.e., the time of physical examination).
- Thus, for people whose SBP is around 140mmHg (a bit above or below), the diagnosis is rather by chance.
- We excluded people who currently under the treatment of hypertension or have been ever diagnosed with hypertension before.

Identification strategy

- People may differently respond to hypertension diagnosis.
 - Increase Exercise
 - Change Diet: amount and quality
- Different responses may be attributable to one's initial knowledge (or belief) about diet and exercise.
- We divide a sample by one's initial DK and ExK:

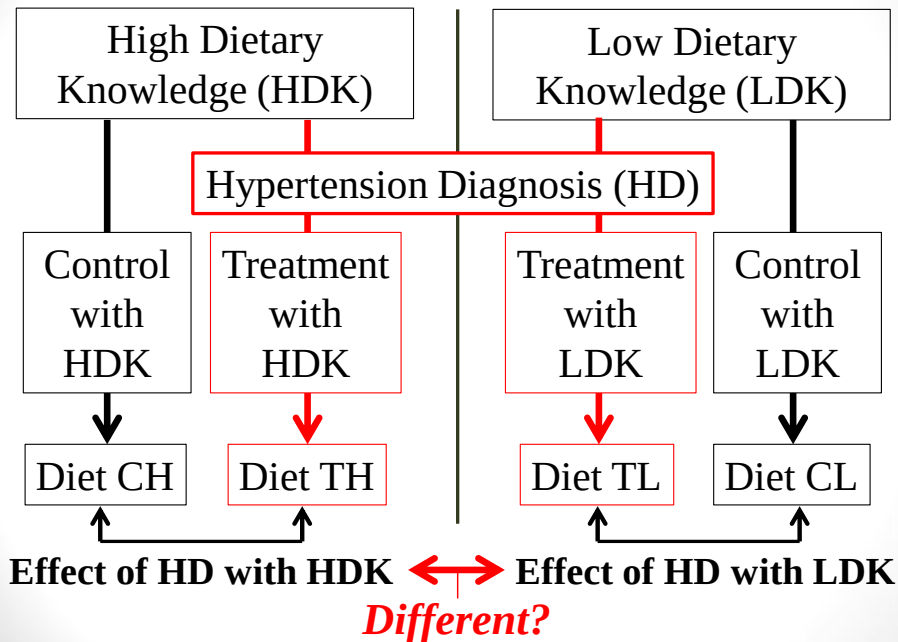
- Two group case:

High DK/ExK	Low DK/ExK
G1	G2

- Four group case:

	High DK	Low DK
High ExK	G1	G2
Low ExK	G3	G4

Example of the Two Group Case



Estimation Method

Sharp Regression Discontinuity (RD) Design

- Treatment: Hypertension Diagnosis (HD)
- Cut-point: systolic blood pressure (SBP) = 140 mmHg
- Compare the average outcome between the sub-samples below and above the cut-point.

Logics

- Because it is impossible to control SBP precisely, among people whose SBP was around the cut-point, some were happen to be above it while others were not.
- Thus, hypertension diagnosis can be considered as a random assignment for those people.

Estimation Method

Non-parametric: Local linear regression (LLR)

- Triangular kernel
- Focus only around the cut-point.
- Optimal bandwidth: cross-validation criterion (Imbens and Lemieux 2008)

Parametric: Quartic polynomial model

- We can add other control variables X_i .

$$D_i = \alpha + \beta HD_i + f(SBP_i) + X_i$$

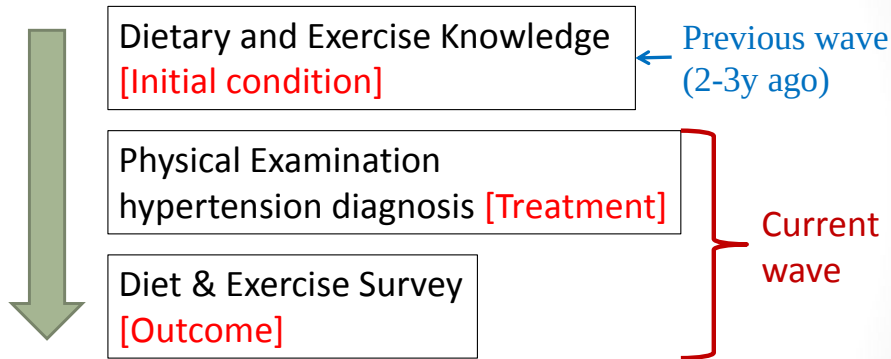
From SBP to SBP^4

$X = \{\text{per capita household income, education level, age, gender, urban residence, survey year}\}$

Data

Data source: CHNS 2004, 2006 and 2009.

- Age ≥ 18 y and $100\text{mmHg} \leq \text{SBP} \leq 180\text{mmHg}$.



- Excluded the subjects who were hypertension in the previous wave or under treatment of hypertension.

Data

Dependent Variables

- Nutrient intake: 3-day average intake of total calorie, and three macronutrient (fat, protein and carbo).
- Exercise: weekly exercise time (min/week).

Key independent variables

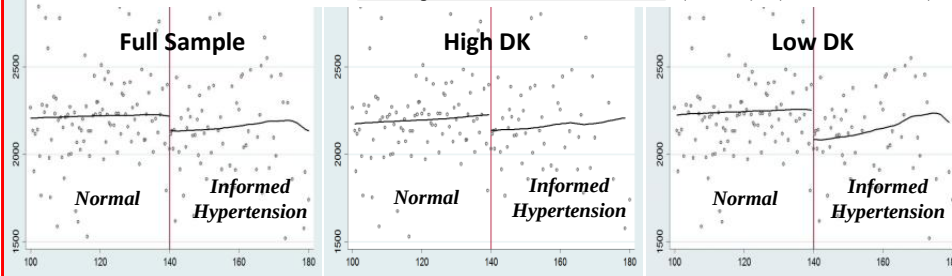
- Hypertension diagnosis indicator: 1 if $SBP \geq 140$, 0 otherwise.
- Lagged Dietary knowledge: dietary knowledge index (DKI).
- Lagged Exercise knowledge: 1 if agree that exercise is good for one's health, 0 otherwise.

Data

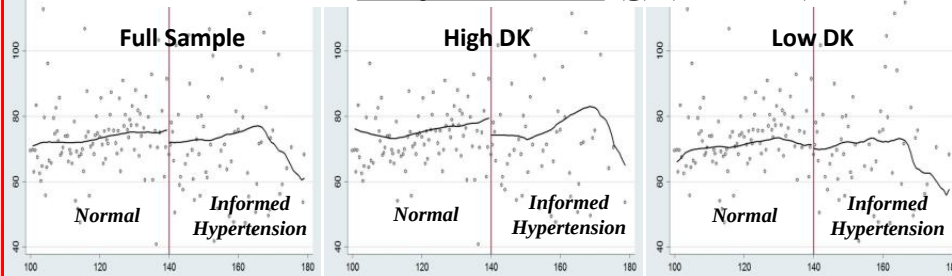
	High DK (DKI ≥ 0.133)		Low DK (DKI < 0.133)	
	Control	Treatment	Control	Treatment
Observation #	1961	274	1966	291
Total calorie (kcal)	2200.2	2145.6	2242.7	2115.8
Age (year)	47.2	58.6	48.5	58.5
Female Ratio	0.511	0.507	0.519	0.598
Per capita HH Income (yuan)	9494.1	11014.1	7149.2	6768.0
Hypertension rate	12.3%		12.8%	

Non-parametric Results by Knowledge Level

Blood Pressure and Daily Calorie Intake (kcal) (bw = 18.6)

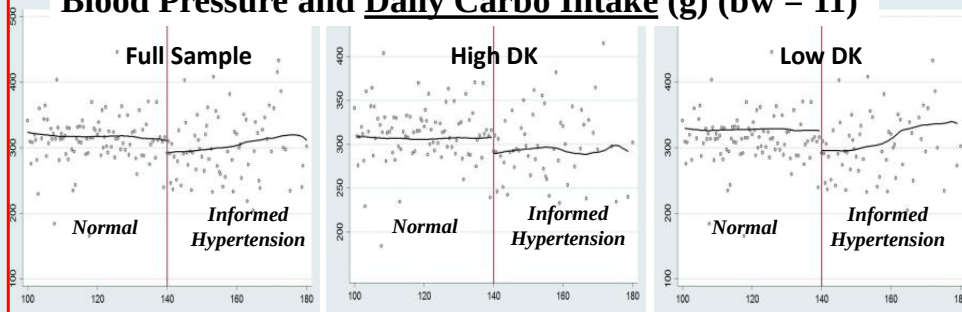


Blood Pressure and Daily Fat Intake (g) (bw = 7.5)

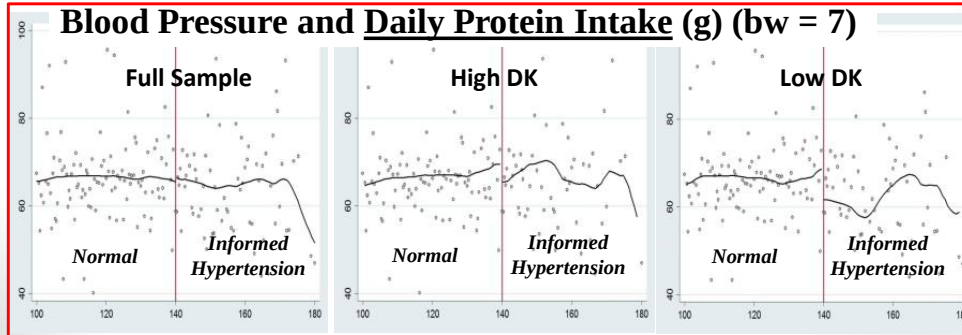


Non-parametric Results by Knowledge Level

Blood Pressure and Daily Carbo Intake (g) (bw = 11)

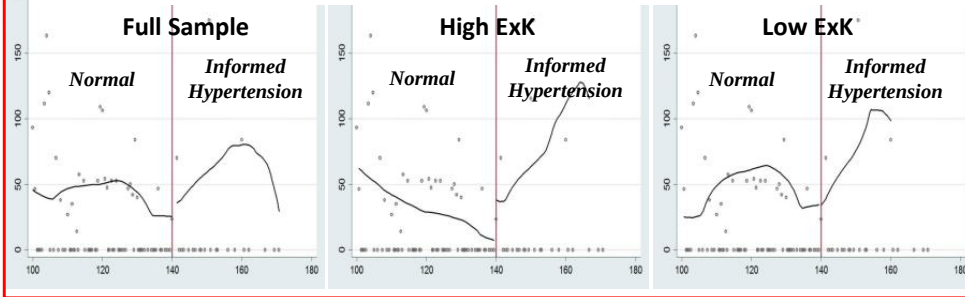


Blood Pressure and Daily Protein Intake (g) (bw = 7)



Non-parametric Results by Knowledge Level

Blood Pressure and Weekly Exercise Time (min) (bw = 12.6)



DK and ExK by Income Level

Per Capita Household Income level	Mean DKI	Proportion of High ExK
Bottom 25%	-0.095	52.2%
Lower middle 25%	-0.026	53.7%
Upper middle 25%	0.075	62.0%
Top 25%	0.169	70.2%

- In parametric estimations, I control for per capita household income, education level, age, gender, urban residence, and year.

Numeric Estimates by DK or ExK

	All	High DK	Low DK
Observation #	4,964	2,658	2,306
Total Calorie (kcal)	HD → -7.4% to -9.2%		
Non-parametric	-140.5**	-163.8*	-137.8
Parametric			
[w/o controls]	-204.2***	-199.0**	-231.2**
[w/ controls]	-181.1***	-201.9**	-189.5**
Fat (g) [opt bw=7.5]	HD → -4.0% to -5.6%		
Non-parametric	-6.9	-13.6^	1.9
Parametric			
[w/o controls]	-6.9*	-9.7*	-3.8
[w/ controls]	-6.2	-10.8**	-1.5

Note: ^ = 15%, * = 10%, ** = 5%, and *** = 1%.

Numeric Estimates by DK or ExK

	All	High DK	Low DK
Carbohydrate (g) [opt bw=11]		HD → -6.4% to -7.2%	
Non-parametric	-25.5**	-22.6	-36.1**
Parametric			
[w/o controls]	-29.6***	-25.3*	-40.1***
[w/ controls]	-28.4***	-25.2*	-38.8***
Protein (g) [opt bw=7]		HD → -1.1% to -1.9%	
Non-parametric	-8.0**	-5.1	-10.4*
Parametric			
[w/o controls]	-5.9***	-4.3	-7.8**
[w/ controls]	-4.8**	-4.5^	-5.9*

Note: ^ = 15%, * = 10%, ** = 5%, and *** = 1%.

Numeric Estimates by DK or ExK

	All	High ExK	Low ExK
Exercise Time (min) [opt bw = 12.6]			
Non-parametric [opt bw=12.6]	24.1	11.0	5.1
Parametric [w/o controls]	-9.1	-21.6	-5.2
[w/ controls]	3.8	1.1	-2.6

Note: ^ = 15%, * = 10%, ** = 5%, and *** = 1%.

Numeric Estimates by DK $\times$ ExK

	High DK High ExK	High DK Low ExK	Low DK High ExK	Low DK Low ExK
Observation #	674	765	607	691
Total Calorie (kcal)	HD $\rightarrow$ -11.7% to -13.3%			
Non-parametric	20.9	-258.2*	-51.8	-149.9
Parametric [w/o controls]	51.9	-293.0**	-241.7	-56.6
[w/ controls]	-11.8	-288.4*	-79.1	-2.1
Fat (g) [opt bw]	HD $\rightarrow$ -6.7% to -11.9%			
Non-parametric	-14.5	-29.0*	21.2**	-5.7
Parametric [w/o controls]	-3.9	-16.4*	-7.5	1.2
[w/ controls]	-4.3	-19.9**	-0.4	3.0

Note: ^ = 15%, * = 10%, ** = 5%, and *** = 1%.

Numeric Estimates by DK × ExK

	High DK High ExK	High DK Low ExK	Low DK High ExK	Low DK Low ExK
Carbohydrate (g) [opt bw=11]			HD	→ -9.0%
Non-parametric	12.5	-23.9	-19.9	-50.7 [^]
Parametric [w/o controls]	15.9	-28.6	-28.6	-15.9
[w/ controls]	3.1	-16.8	-14.4	-12.1
Protein (g) [opt bw=7]				
Non-parametric	1.2	-2.7	2.6	-3.7
Parametric [w/o controls]	1.3	-1.5	-8.1	-2.0
[w/ controls]	0.2	-3.7	-2.2	0.6

Note: [^] = 15%, * = 10%, ** = 5%, and *** = 1%.

Numeric Estimates by DK $\times$ ExK

	High DK High ExK	High DK Low ExK	Low DK High ExK	Low DK Low ExK
Exercise Time (min) [opt bw=11]				
Non-parametric	127.2	39.0	-49.9	-15.4
Parametric [w/o controls]	13.0	-29.9	-56.7 [^]	44.6
[w/ controls]	44.6	-75.9 [^]	-41.2	69.2 ^{**}

Note: [^] = 15%, * = 10%, ** = 5%, and *** = 1%.

Mean Income by DK $\times$ ExK Level

DK and ExK	Mean pc Household Income (2009 yuan)	Response
High DK & High ExK	11325.2	
High DK & Low ExK	8334.4	***
Low DK & High ExK	8615.1	*
Low DK & Low ExK	6599.1	

- The response is larger among the middle income groups rather than the high income group.
- Knowledge does matter.

結論とまとめ

- 少なくとも我々の中国のサンプルでは、「健康な食生活の知識の効果」と「健康な運動の知識の効果」は補完関係ではなく、代替関係にあることが示唆された。特に、「健康な運動の知識」が改善すると、「健康な食生活の知識」が食生活改善に与える効果が減少する傾向がみられた。
- 知識改善の効果として、「食生活改善の効果」は見られたが、「運動促進の効果」を示す有意な証拠は見つからなかった（時間的制約の可能性）。
- これら結果は、食生活と運動の重要性を同程度に強調することのリスクを示唆している。
- 例えば、食育などで食生活と運動の重要性を同程度に強調すると、結果として「食生活改善の効果」は減少し、「運動促進の効果」はもともと極めて小さい可能性がある。