26th Spring Congress of Korean Diabetes Association

Metabolic Syndrome and Environmental Influences
- Insight from North Korean refugees

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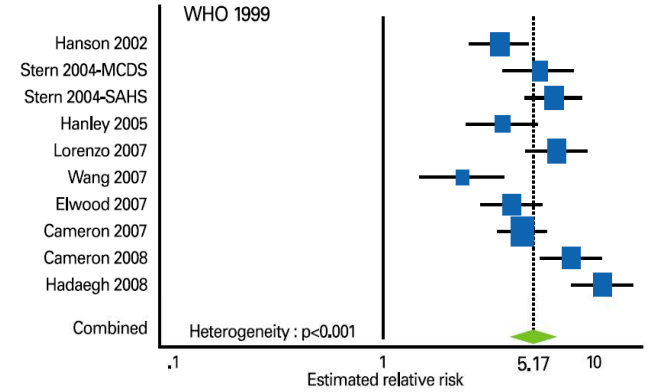
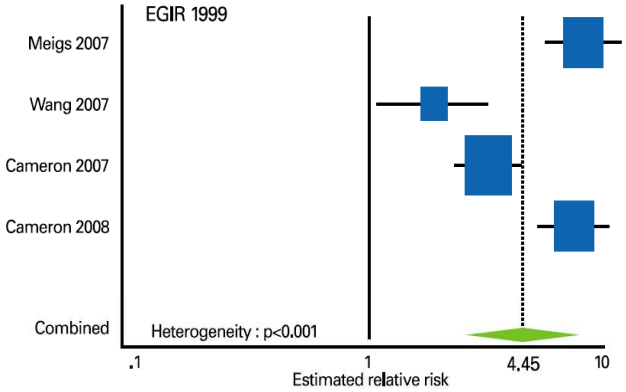
What is Metabolic Syndrome?

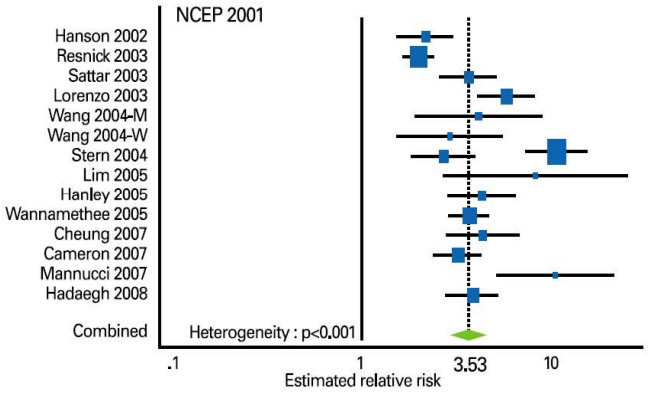
- Cluster of metabolic abnormalities that typically occur together and results in significantly increased risk of
  - Type 2 diabetes
  - Cardiovascular disease

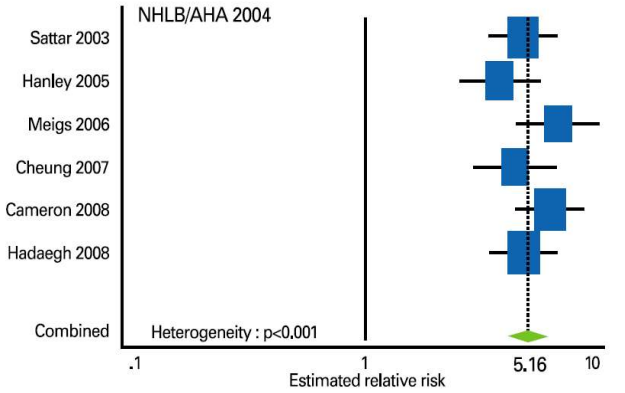
Estimates of RR from prospective studies examining the associations between the metabolic syndrome and incident diabetes

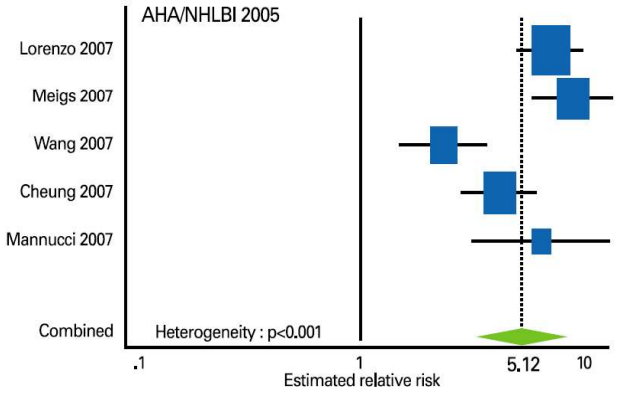
Ford ES. Et al, Diabetes Care 2008

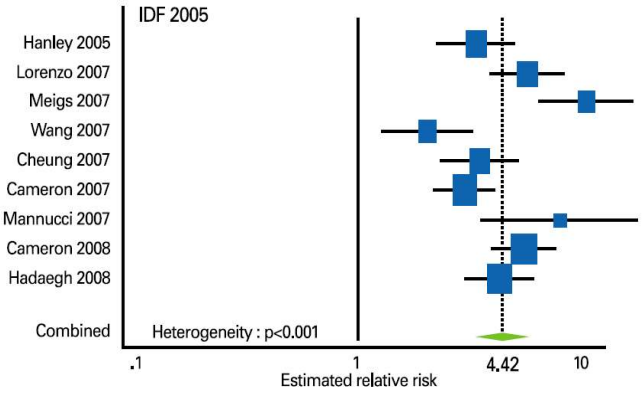




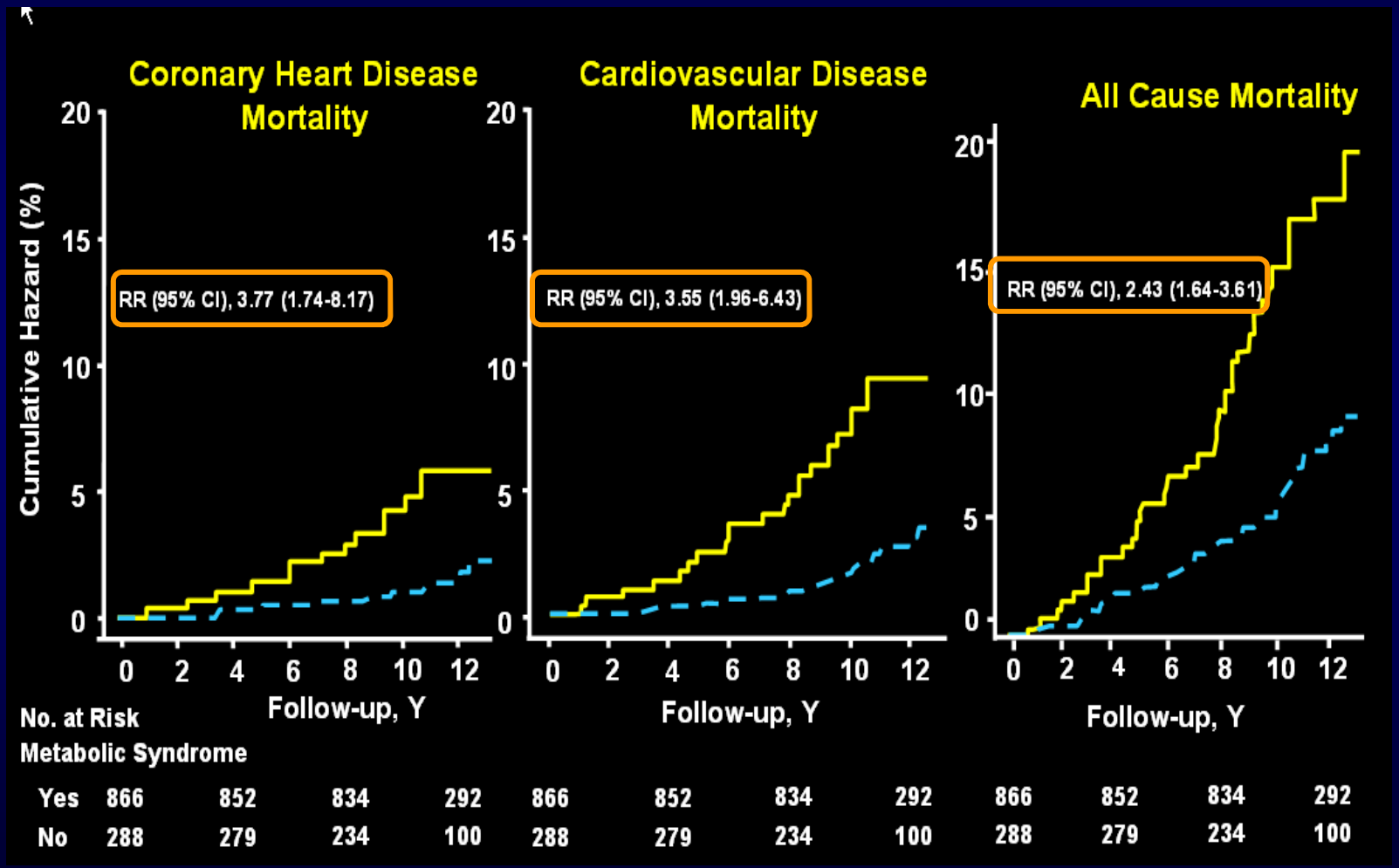








Mortality of Metabolic Syndrome (MetS)



Lakka et al. JAMA 288:2709-2716, 2002

How Is MetS Defined?

Five Current Definitions of Metabolic Syndrome

Clinical Measure	WHO (1998)	EGIR	ATP III (2001)	AACE (2003)	IDF (2005)
Insulin resistance	IGT, IFG, T2DM, or lowered insulin sensitivity* **plus any 2 of the following**	Plasma insulin >75th percentile **plus any 2 of the following**	None, **but any 3 of the following 5 features**	IGT or IFG **plus any of the following based on clinical judgment**	None
Body weight	Men: waist-to-hip ratio >0.90; women: waist-to-hip ratio >0.85 and/or BMI >30 kg/m^2	WC ≥94 cm in men or ≥80 cm in women	WC ≥102 cm in men or ≥88 cm in women†	BMI ≥25 kg/m^2	Increased WC (population specific) **plus any 2 of the following**
Lipid	TG ≥150 mg/dL and/or HDL-C <35 mg/dL in men or <39 mg/dL in women	TG ≥150 mg/dL and/or HDL-C <39 mg/dL in men or women	TG ≥150 mg/dL HDL-C <40 mg/dL in men or <50 mg/dL in women	TG ≥150 mg/dL and HDL-C <40 mg/dL in men or <50 mg/dL in women	TG ≥150 mg/dL or on TG Rx HDL-C <40 mg/dL in men or <50 mg/dL in women or on HDL-C Rx
Blood pressure	≥140/90 mm Hg	≥140/90 mm Hg or on hypertension Rx	≥130/85 mm Hg	≥130/85 mm Hg	≥130 mm Hg systolic or ≥85 mm Hg diastolic or on hypertension Rx
Glucose	IGT, IFG, or T2DM	IGT or IFG (but not diabetes)	>110 mg/dL (includes diabetes)‡	IGT or IFG (but not diabetes)	≥100 mg/dL (includes diabetes)
Other	Microalbuminuria			Other features of insulin resistance§	

T2DM indicates type 2 diabetes mellitus; WC, waist circumference; BMI, body mass index; and TG, triglycerides. All other abbreviations as in text.

*Insulin sensitivity measured under hyperinsulinemic euglycemic conditions, glucose uptake below lowest quartile for background population under investigation.

†Some male patients can develop multiple metabolic risk factors when the waist circumference is only marginally increased (eg, 94 to 102 cm [37 to 39 in]). Such patients may have a strong genetic contribution to insulin resistance. They should benefit from changes in lifestyle habits, similar to men with categorical increases in waist circumference.

‡The 2001 definition identified fasting plasma glucose of ≥110 mg/dL (6.1 mmol/L) as elevated. This was modified in 2004 to be ≥100 mg/dL (5.6 mmol/L), in accordance with the American Diabetes Association's updated definition of IFG.[46,47,77]

§Includes family history of type 2 diabetes mellitus, polycystic ovary syndrome, sedentary lifestyle, advancing age, and ethnic groups susceptible to type 2 diabetes mellitus.

Circulation. 2005;112:2735-2752

Joint Scientific Statement

Harmonizing the Metabolic Syndrome

A Joint Interim Statement of the International Diabetes Federation Task Force on Epidemiology and Prevention; National Heart, Lung, and Blood Institute; American Heart Association; World Heart Federation; International Atherosclerosis Society; and International Association for the Study of Obesity

K.G.M.M. Alberti, FRCP; Robert H. Eckel, MD, FAHA; Scott M. Grundy, MD, PhD, FAHA; Paul Z. Zimmet, MD, PhD, FRACP; James I. Cleeman, MD; Karen A. Donato, SM; Jean-Charles Fruchart, PharmD, PhD; W. Philip T. James, MD; Catherine M. Loria, PhD, MS, MA, FAHA; Sidney C. Smith, Jr, MD, FAHA

Circulation October 20, 2009

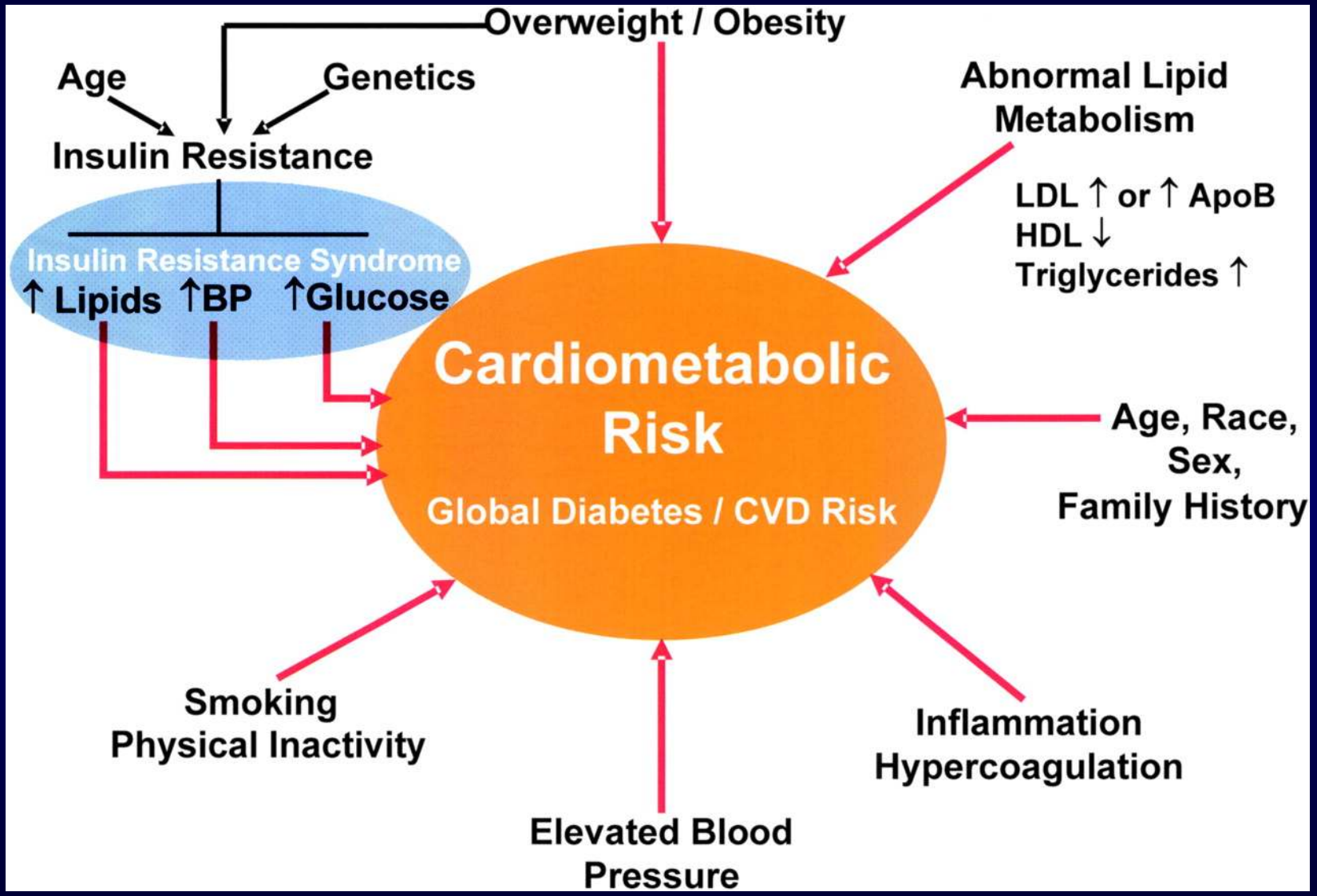
Measure	Categorical Cut Points
Elevated waist circumference*	Population- and country-specific definitions
Elevated triglycerides (drug treatment for elevated triglycerides is an alternate indicator†)	≥150 mg/dL (1.7 mmol/L)
Reduced HDL-C (drug treatment for reduced HDL-C is an alternate indicator†)	<40 mg/dL (1.0 mmol/L) in males; <50 mg/dL (1.3 mmol/L) in females
Elevated blood pressure (antihypertensive drug treatment in a patient with a history of hypertension is an alternate indicator)	Systolic ≥130 and/or diastolic ≥85 mm Hg
Elevated fasting glucose‡ (drug treatment of elevated glucose is an alternate indicator)	≥100 mg/dL

HDL-C indicates high-density lipoprotein cholesterol.

*It is recommended that the IDF cut points be used for non-Europeans and either the IDF or AHA/NHLBI cut points used for people of European origin until more data are available.

What Are the Risk Factors of Metabolic Syndrome?

Cardiometabolic Risk



Diabetes Care. 2005;28(9):2289-304

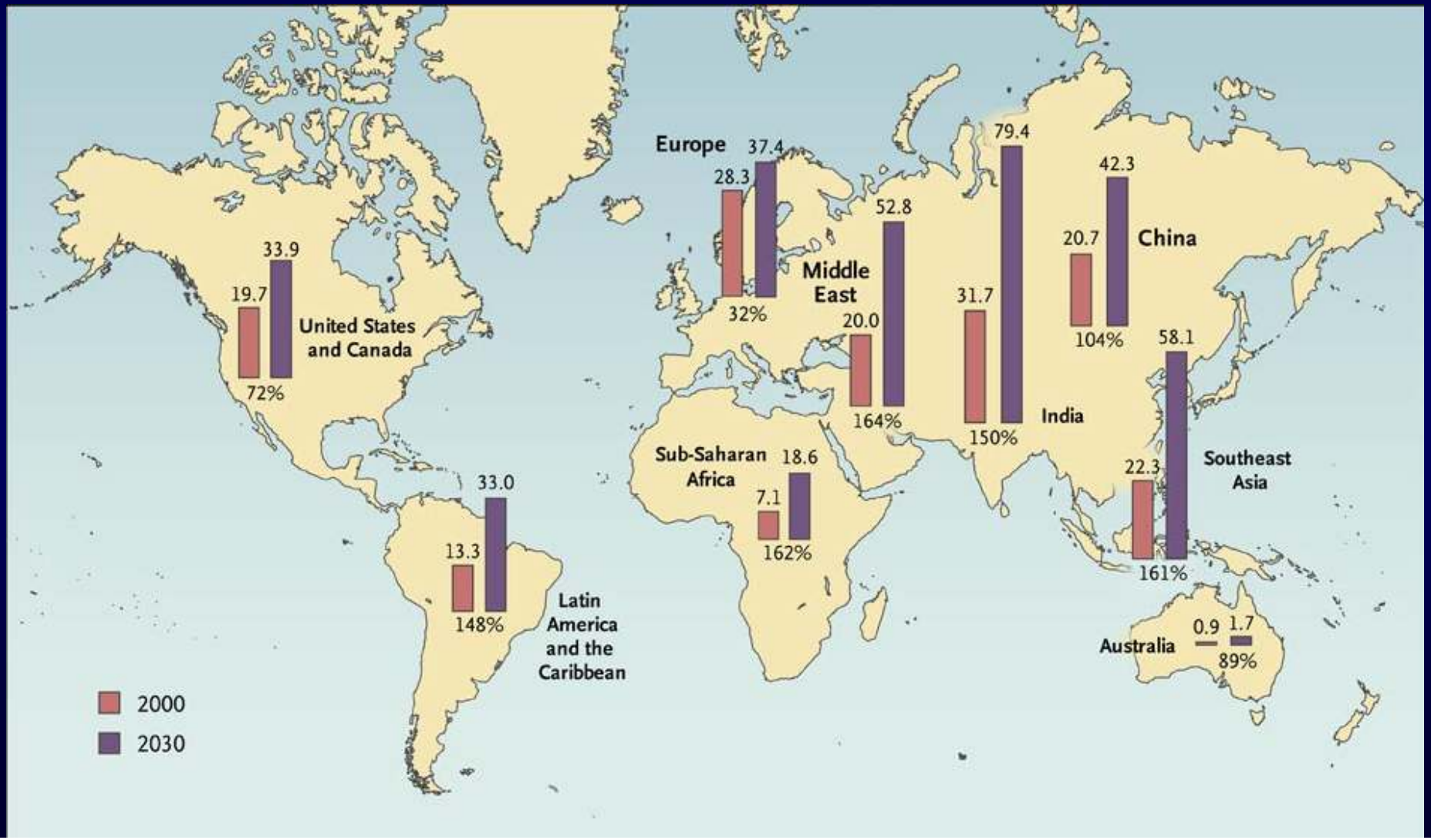
Risk Factors for MetS

- **Demographic risk factors**
  - age, sex, and population subgroups
- **Genetic risk factors**
- **Behavioral risk factors**
  - diet and nutrition, physical inactivity, smoking, excessive alcohol consumption etc
- **Environmental risk factors**
  - chemical and biological, social, economic, cultural and political

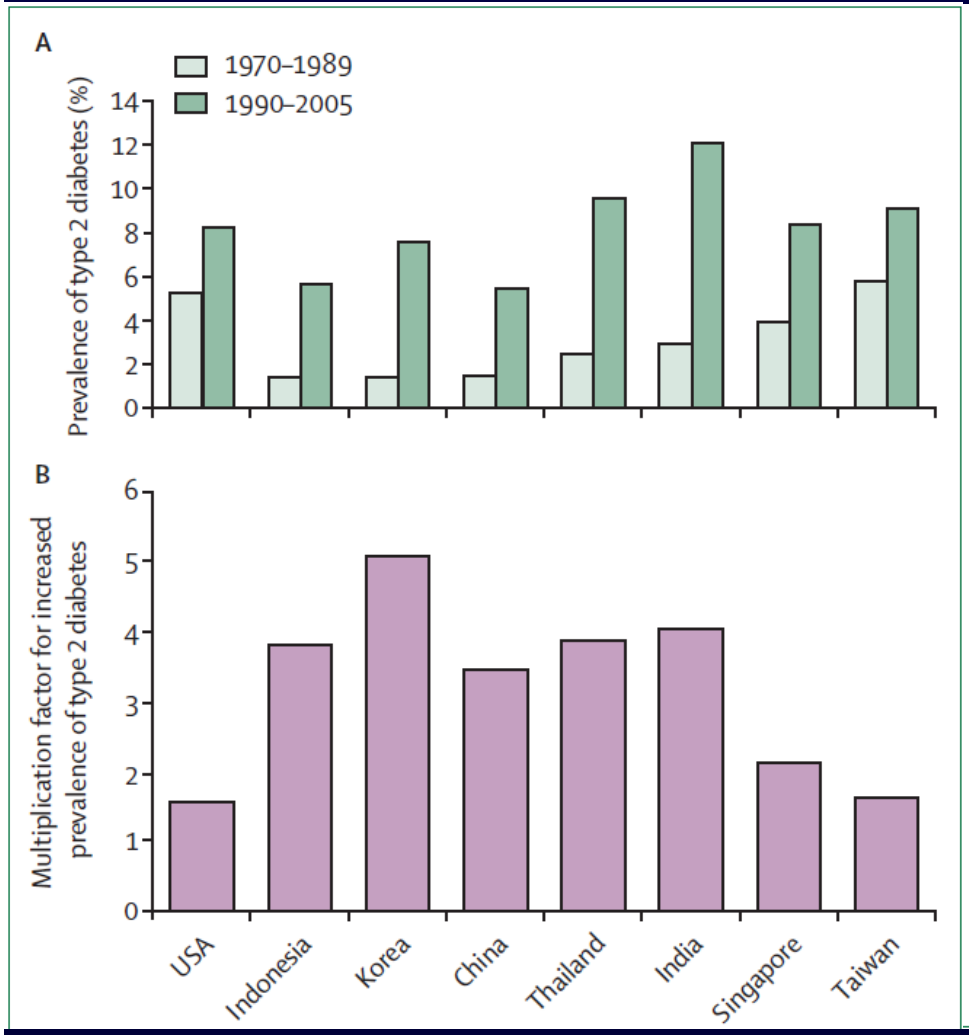
Prevalence of MetS and Diabetes in Asia including Korea

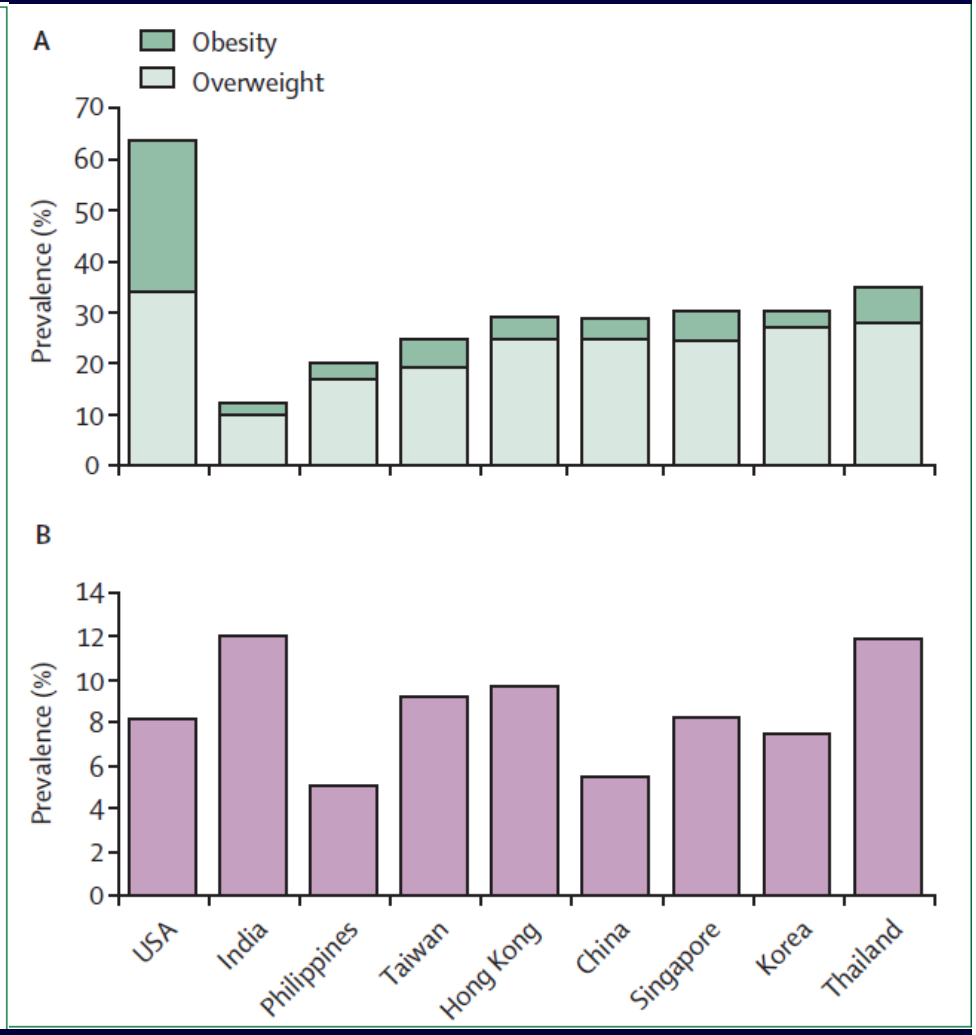
Obesity and Diabetes in the Developing World — A Growing Challenge.

Hossain P, Kawar, B, and Nahas ME. NEJM 356:213-215 *2007*



Same Body Mass Index, Higher Risk for Diabetes in Asians





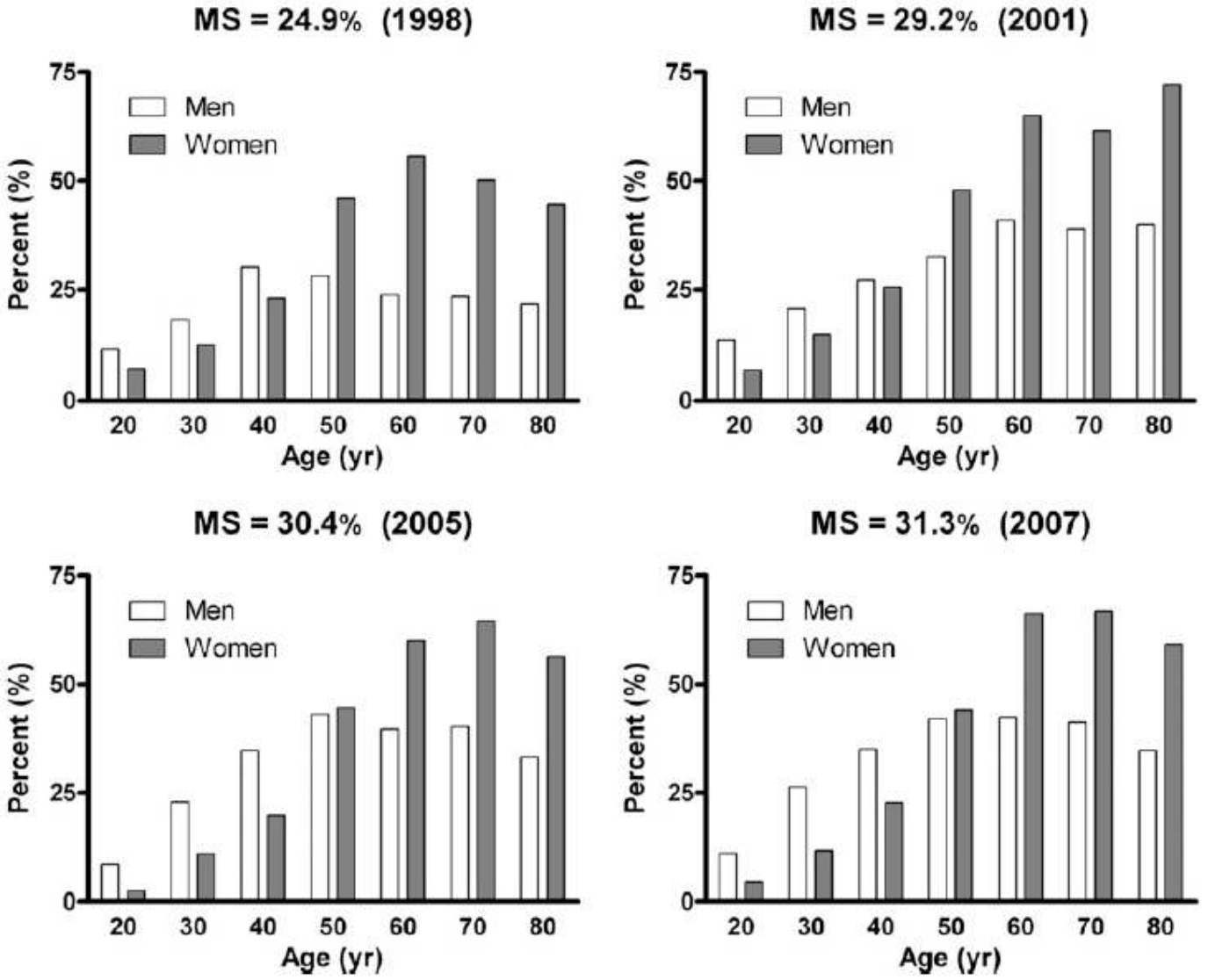


Figure 1—*Prevalence of metabolic syndrome (MS) among Korean adults by sex in the 1998, 2001, 2005, and 2007 KNHANESs, according to age-groups. The revised NCEP Adult Treatment Panel III definition with Asia-Pacific abdominal obesity criteria was used.*

Diabetes Prevalence in Korea According to Various Surveys

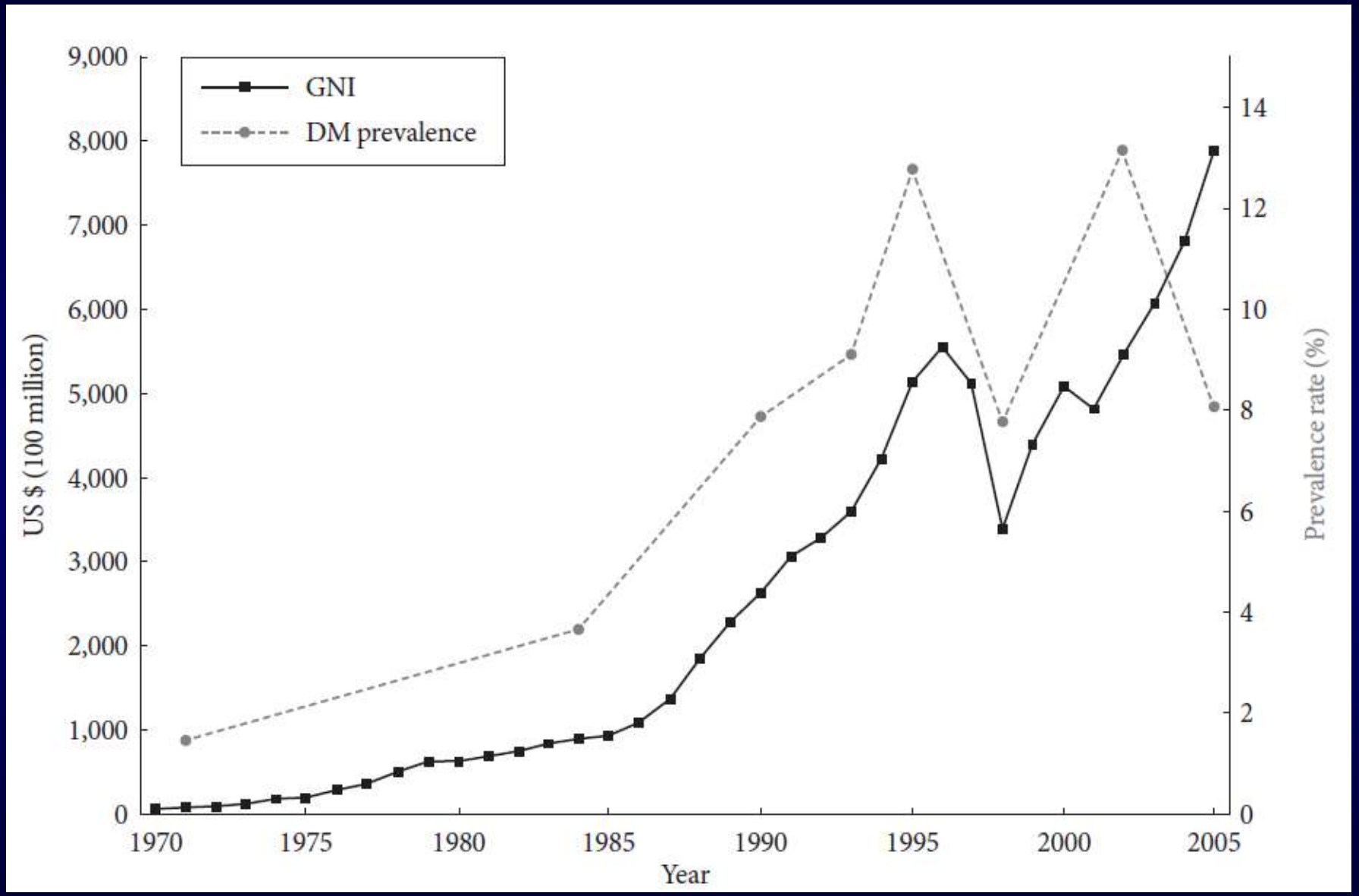
Data source	Year	Age distribution	Methods of diagnosis	Prevalence	Adjustment for age
Rural (1)	1971	>30	UG+50g OGTT	1.5%	Not adjusted
Rural (5)	1993	>30	75g OGTT	6.3%	Adjusted
Specific employee*(7)	1992	28~59	FBG	3.03%	Adjusted
	2000			6.29%	Adjusted
Rural (6)	1997	>30	75g OGTT	6.9%	Adjusted
	2003			11.7%	Adjusted
National health insurance (3)	2003	20~79	FBG/PP2hr BG diabetes code Hx of DM med	7.7%	Adjusted
KNHNES (2)	1998	>20 (>30)	FBG	9.3(11.1)%	Adjusted
	2001			7.7(8.9)%	Adjusted
	2005			7.3(9.1)%	Adjusted

* Male employees of Korean government organization and school.

UG=urinary glucose. OGTT=oral glucose tolerance test. FBG= fasting blood glucose. PP2hr BG=post-prandial 2hour blood glucose. Hx of DM med=History of diabetic medication. KNHNES= Korean national health and nutrition examination survey.

Kim SG and Choi DS, KAMA, Aug 2008

The prevalence of diabetes and gross national income (GNI)



Korean Diabetes J 2010;34:10-15

Why Has Diabetes Increased in Asia, including Korea?

- Increasing overall and abdominal Obesity
- Nutrition transition and changes in diet and lifestyle
- Pancreatic beta cell function
- Developmental origins of diabetes
- Genetic susceptibility

JAMA, May 27, 2009—Vol 301, No. 20

Several Theories for Explaining High Prevalence of MetS and Diabetes in Asia

1. Genetic cause (thrifty genotype hypothesis. Neel JV, 1962)
2. Fetal malnutrition (thrifty phenotype hypothesis. Barker DJP and Hales CN, 1992)
3 Mitochondrial dysfunction (Lee HK et al, 2006)
4. Environmental chemicals (Baillie-Hamilton PF, 2002) and POPs (Lee DH et al, 2006)

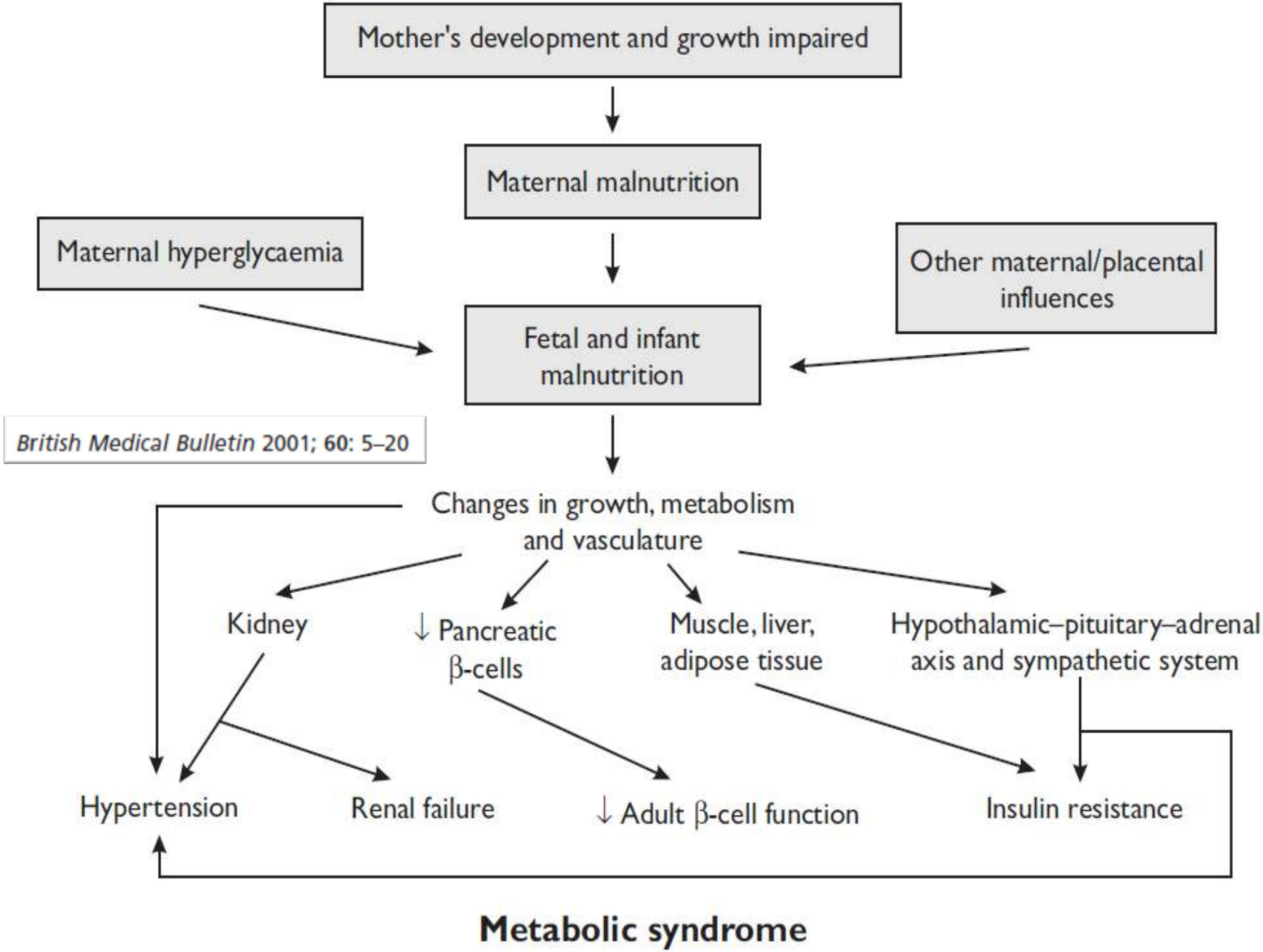
The thrifty phenotype hypothesis

C Nicholas Hales* and **David J P Barker†**

**Department of Clinical Biochemistry, University of Cambridge, Addenbrooke's Hospital, Cambridge, UK and †MRC Environmental Epidemiology Unit, Southampton General Hospital, Southampton, UK*

British Medical Bulletin 2001; 60: 5–20

The thrifty phenotype hypothesis was put forward in **1992** in **an attempt to explain the associations between poor fetal and infant growth** and **increased risk of developing impaired glucose tolerance and the MetS** in adult life.


Mother's development and growth impaired
Maternal malnutrition
Maternal hyperglycaemia
Other maternal/placental influences
Fetal and infant malnutrition
British Medical Bulletin 2001; 60: 5–20
Changes in growth, metabolism and vasculature
Kidney
↓ Pancreatic β-cells
Muscle, liver, adipose tissue
Hypothalamic–pituitary–adrenal axis and sympathetic system
Hypertension
Renal failure
↓ Adult β-cell function
Insulin resistance
Metabolic syndrome

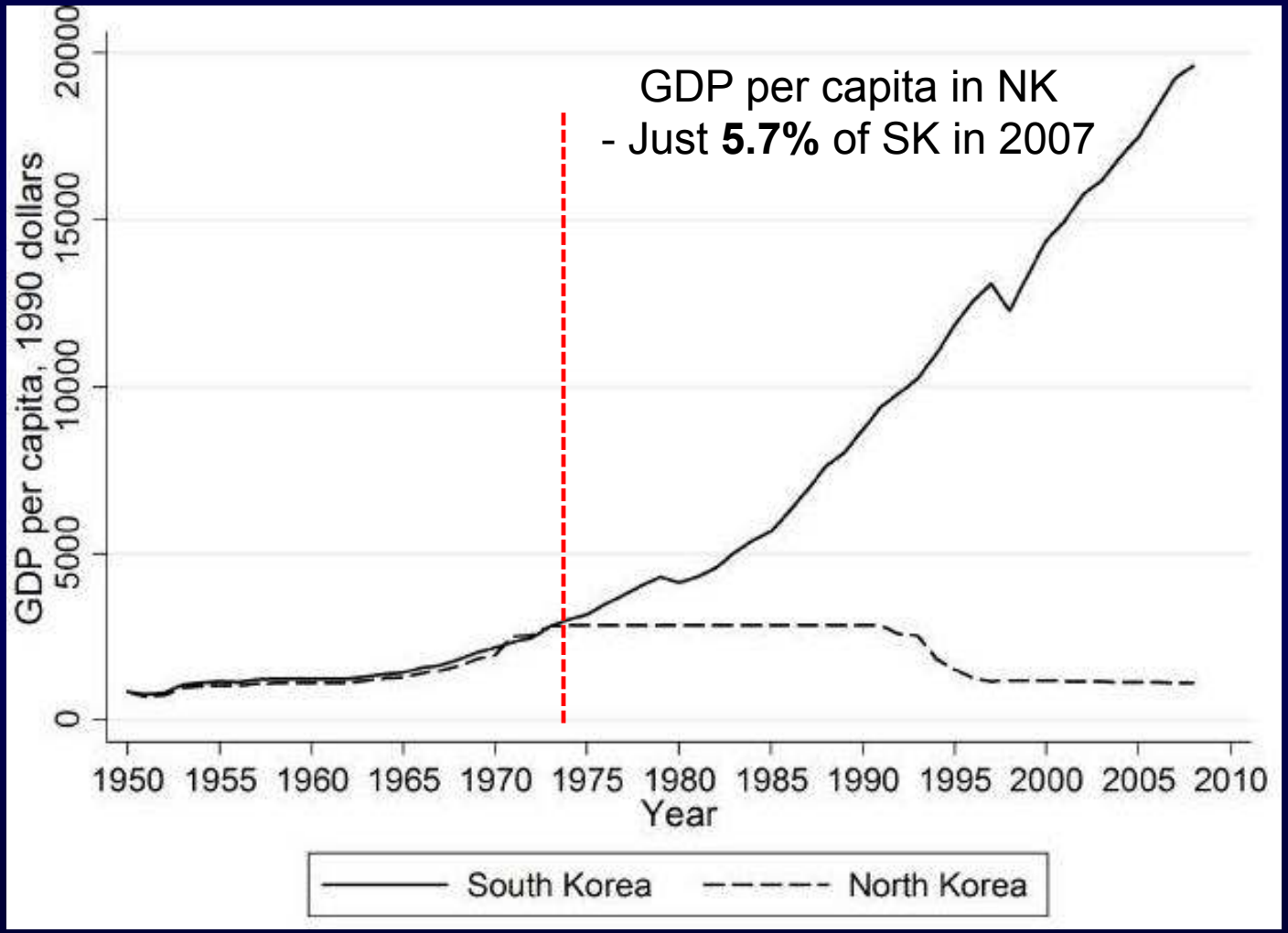
North Korean Refugees – Relevant Cohort for the Thrifty Phenotype Hypothesis


Russia
Mongolia
China
North
Korea
South
Japan

North and South Korea

- North and South Korea, **originally a united country**, were divided during the Cold War and have since been situated in **different politico-social environments**.
- While **South Korea has experienced drastic economic growth and modernization**, **North Korea has suffered great economic hardship and famine** as a result of the collapse of the Communist bloc and consecutive natural disasters

Per Capita GDP
- North Korea vs South Korea (1950-2010)



Data from the Historical Statistics for the World Economy.

North Korean Famine

- **The North Korean famine** lasted **from 1994 to 1998**.
- Out of a total population of approximately 22 million, **somewhere between 240,000 and 3,500,000 people** died from starvation or hunger-related illnesses, with the deaths peaking in 1997.

Noland, Marcus, Sherman Robinson and Tao Wang, Famine in North Korea: Causes and Cures, Institute for International Economics.

Exodus from North Korea

- Since 1998, there has been **a growing exodus of North Korean refugees** (NKRs) seeking food or a better life, primarily into China as a first asylum country. Many of them are known to hope to **permanently resettle in South Korea**.
- In fact**, the number of NKRs** entering South Korea each year has increased steadily since 2000 and **the total number of NKRs in South Korea** was set to exceed **23,000** as of the end of 2011.

Ministry of Unification, Republic of Korea: Current status of North Korean refugees‘ resettlement

North Korean Refugees - A Unique Immigrant Group

- NKRs have **the same genetic characteristics as South Koreans** but have been exposed to **two-step changes**, a different environment due **to the division** of two Koreas and then also **resettlement** in South Korea
- A unique type of migration study, because ordinary migration studies usually investigate differences between a group that did not migrate and a group that migrated to different nations.

NKRs – Relevant Cohort for the Thrifty Phenotype Hypothesis

- **Rapid change from extreme poverty to wealth**
- Provide significant data on correlations between **changes of environment and diseases** and on the **thrifty phenotype hypothesis**

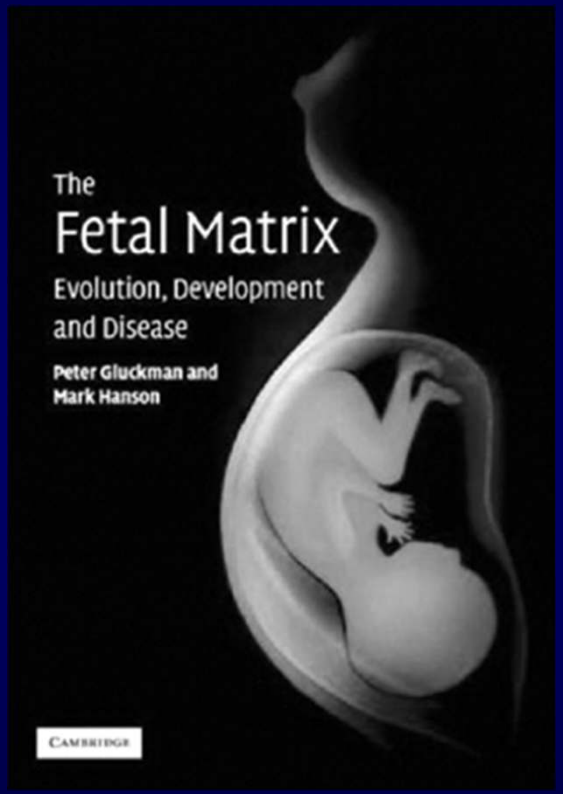
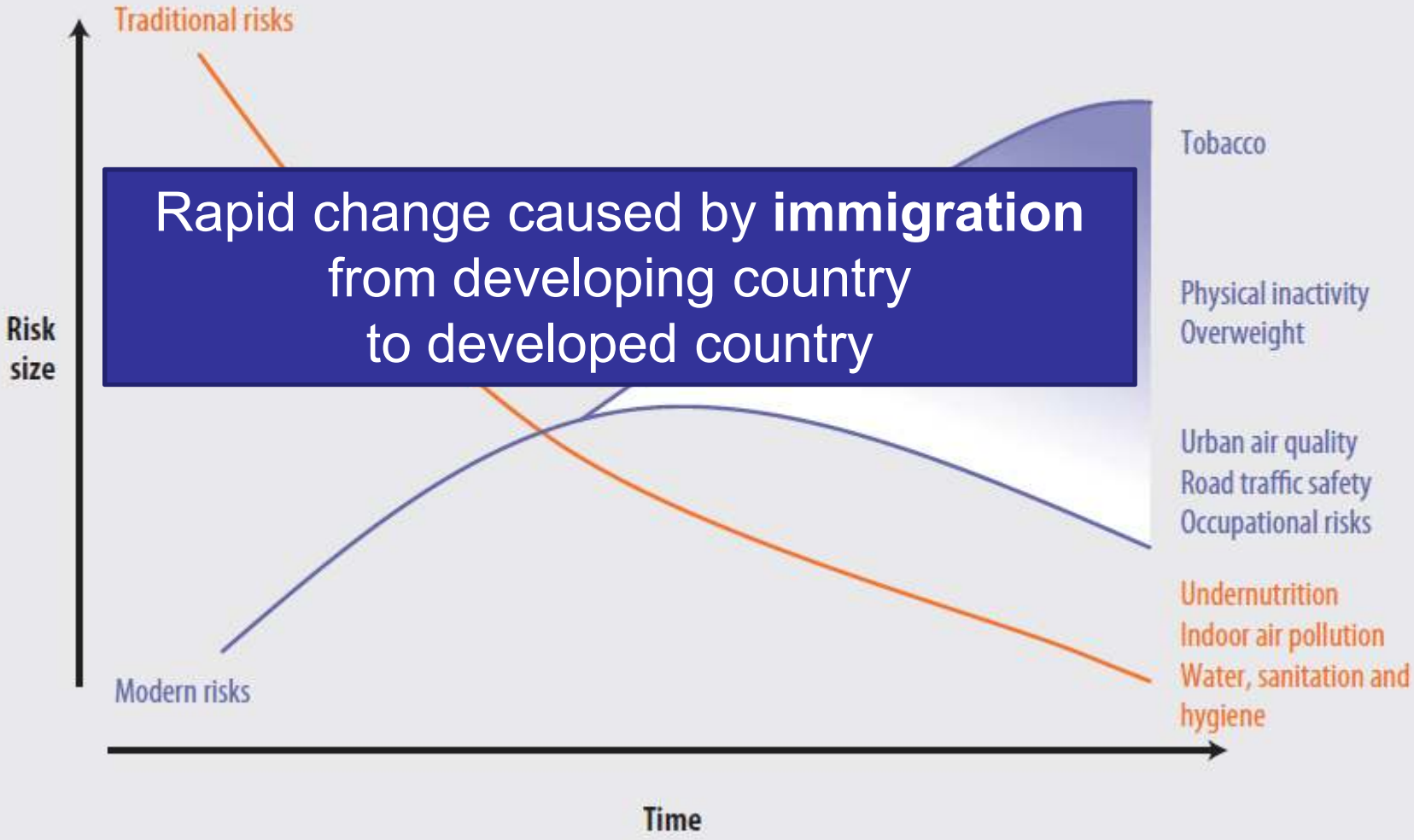


Figure 2: The risk transition. Over time, major risks to health shift from traditional risks (e.g. inadequate nutrition or unsafe water and sanitation) to modern risks (e.g. overweight and obesity). Modern risks may take different trajectories in different countries, depending on the risk and the context.



Global health risks: mortality and burden of disease attributable to selected major risks. World Health Organization 2009

Lee et al. BMC Public Health 2012, 12:172
http://www.biomedcentral.com/1471-2458/12/172

BMC Public Health

STUDY PROTOCOL Open Access

North Korean refugee health in South Korea (NORNS) study: study design and methods

Yo Han Lee[1], Won Jin Lee[1], Yun Jeong Kim[2], Myong Jin Cho[2], Joo Hyung Kim[2], Yun Jeong Lee[3], Hee Young Kim[2], Dong Seop Choi[2], Sin Gon Kim[2*] and Courtland Robinson[4]

Author details

[1]Department of Preventive Medicine, Korea University College of Medicine, Seoul, South Korea. [2]Division of Endocrinology and Metabolism, Department of Internal Medicine, Korea University Anam Hospital, Seoul, South Korea. [3]Department of Internal Medicine, Inje University Ilsan Paik Hospital, Goyang, South Korea. [4]Department of International Health, Center for Refugee and Disaster Response, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA.

NORNS Study

- This cohort began in 2008 having the two purposes, one is humanitarian and the other one is research.
- Our cohort is ongoing and more than 650 refugees have enrolled up to now. Recently, follow-up surveys and examinations have begun with a 3.5 year interval.

NORNS

The **NO**rth Korean **R**efugee health i**N** **S**outh Korea

The **NORNS** are the **Goddesses of Destiny in Norse mythology**, who rule **the past, the present, and the future** and shape the lives of humans from their first day to their last.

Subjects & Methods

- **Target population:**
  - All North Korean refugees
- **Intended sample:**
  - Aged 30 or more residing in Seoul
    -> will expand to younger subjects
- **Methods:**
  - Questionnaires
  - Medical check-up
- **Place and time:**
  - Korea University Anam hospital
  - Monthly

Questionnaires – 39 items

- Demographic characteristics
- Medical (disease) history
- Life style (smoking, alcohol, exercise etc)
- Women-specific conditions (menstruation, pregnancy, menopause etc)
- Perceived discrimination scale (3 item)
- Center for Epidemiological Studies
  -Depression Scale – (20 item)
- Sociocultural adaptation scale (29 item)
- PWI-SF (18 item)

Medical Screening

- Blood tests (hemoglobin, liver and renal function, glucose, insulin, thyroid hormones, serum lipids, other metabolic tests)
- Urine tests: RBC, WBC, protein, bacteria et al
- Blood pressure, heart rate
- Body composition analysis
- Test for atherosclerosis
- Ultra-sonograph for thyroid
- Gastroendoscopy
- Bone density measurement (2^{nd} wave)
- Ultra-sonograph for fatty liver (2^{nd} wave)

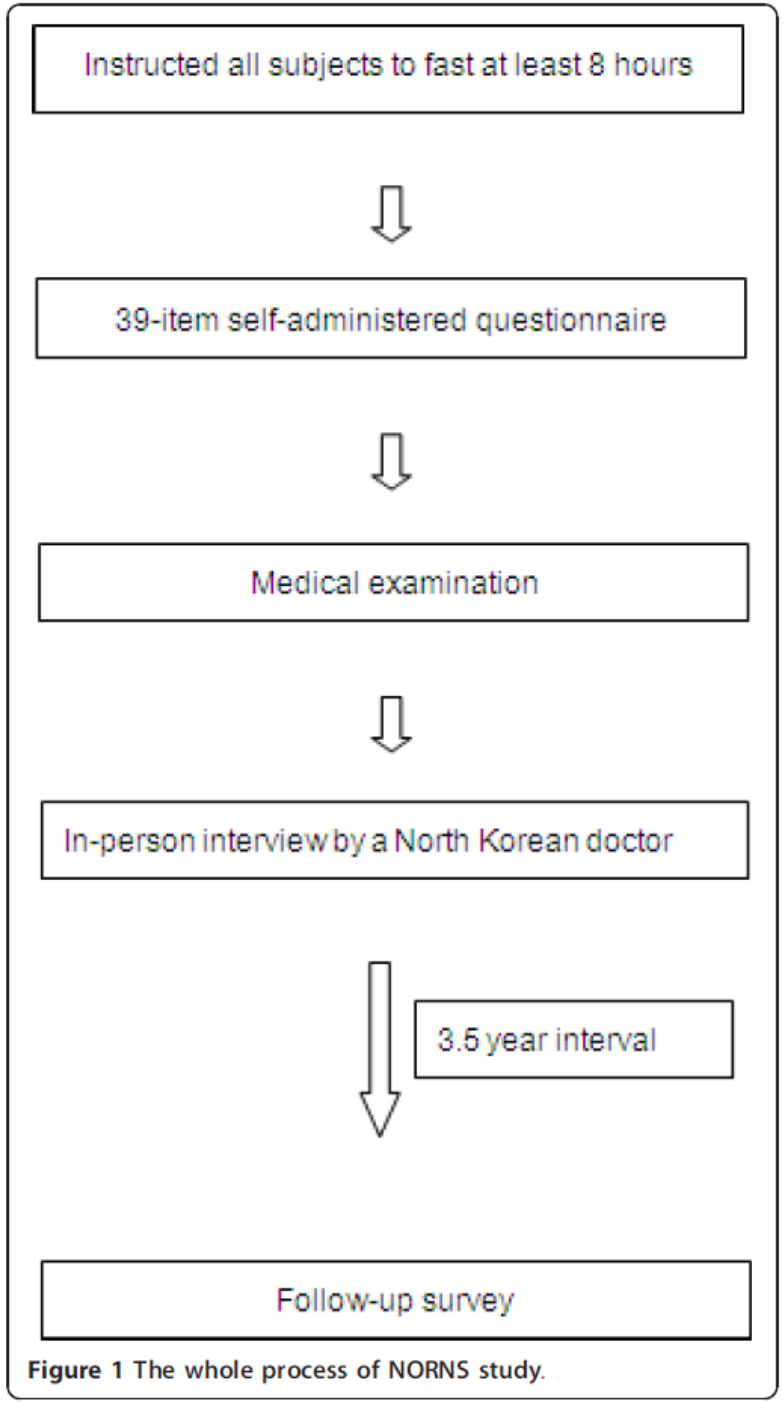


Figure 1 The whole process of NORNS study.

Prevalence of lifestyle related chronic diseases among adult North Korean refugees in South Korea: A comparison study with South Korean counterparts

Yo Han Lee,[1] Won Jin Lee,[1] Yoon Jung Kim,[2] Joo Hyung Kim,[2] Yun Jeong Lee,[3] Hee Young Kim,[2] Nan Hee Kim[2], Kyung Mook Choi[2], Sei Hyun Baik[2], Dong Seop Choi,[2] Sin Gon Kim[2], W. Courtland Robinson[4]

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[3]Department of Internal Medicine, Inje University Ilsan Paik Hospital, Goyang, Korea

[4]Department of International Health, Center for Refugee and Disaster Response, Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, USA

Study Subjects

- A medical check-up was conducted among **440 NKRs** residing in Seoul.
- To select **South Korean subjects (SKS)**, the database of 2008 KNHANES, a representative nationwide health survey of South Korean people was used. Among the total number of subjects of 2008 KNHANES, **880 subjects** who were **age- and sex- matched** to each **NKR subject (NKRS)** with **a 2:1 ratio were sampled randomly** to ensure comparability between the two groups.

	Male					Female				
	NKRS(N=110)		SKS(N=220)			NKRS(N=330)		SKS(N=660)		
	N	%	N	%	p-value	N	%	N	%	p-value
Age										
Mean(SD)	46.9(12.4)		46.9(12.4)			42.6(10.6)		42.6(10.6)		
30-39	38	34.6	76	34.6		157	47.6	314	47.6	
40-49	34	30.9	68	30.9		98	29.7	196	29.7	
50-59	14	12.7	28	12.7		37	11.2	74	11.2	
60-	24	21.8	48	21.8		38	11.5	76	11.5	
Education					0.373					<0.001
Primary school or less	2	2.0	37	16.7		2	0.7	110	16.7	
Middle/high school	50	49.5	89	42.9		168	54.2	318	50.1	
Vocational school	20	19.8	31	13.6		83	26.8	97	14.6	
College or more	29	28.7	57	26.8		57	18.4	122	18.6	
Marital status					0.009					<0.001
Married	85	80.2	193	90.2		211	69.9	607	94.3	
Unmarried	21	19.8	20	9.4		91	30.1	35	5.4	
Family income(10,000won/months)					<0.001					<0.001
<50	23	32.4	28	13.0		103	48.6	90	13.5	
≥50 & <100	27	38.0	19	8.7		77	36.3	61	8.9	
≥100 & <150	12	16.9	18	8.2		13	6.2	69	10.2	
≥200	9	12.7	146	70.1		19	9.0	28	67.4	
Alcohol drinking					0.467					0.023
Current drinker	80	86.0	169	84.9		130	56.7	387	69.4	
Nondrinker	14	14.0	30	15.1		99	43.3	170	31.6	

	Male					Female				
	NKRS(N=110)		SKS(N=220)			NKRS(N=330)		SKS(N=660)		
	N	%	N	%	p-value	N	%	N	%	p-value
Smoking					0.325					0.050
Ex & current smoker	85	88.5	181	86.1		15	6.8	58	9.5	
Nonsmoker	11	11.5	29	13.9		208	93.3	552	90.5	
Regular exercise					0.107					0.945
Yes	31	40.3	99	47.8		68	29.9	188	29.2	
No	46	59.7	118	52.2		152	69.1	455	69.9	
Length of stay in South Korea(months)										
Mean(SD)	41.0(35.8)					36.6(30.0)				
< 12	27	24.8				91	28.1			
12-24	18	16.5				45	13.9			
24-48	25	22.9				87	26.9			
≥48	39	35.8				101	31.2			
Length of stay in first-asylum country(months)										
Mean(SD)	23.2(31.5)					49.5(43.4)				
< 12	62	56.9				95	29.5			
12-24	14	12.8				22	6.8			
24-48	13	11.9				46	14.3			
≥48	20	18.4				159	49.4			

SD: standard deviation

	Male			Female		
	NKRS(N=110)	SKS(N=220)	Gap	NKRS(N=330)	SKS(N=660)	Gap
Height (cm)						
30-39	166.5(6.9)	172.5(5.8)	6.0	154.8(5.0)	159.6(5.3)	5.1
40-49	167.2(5.0)	169.8(5.8)	2.6	154.2(5.5)	157.5(5.2)	3.3
50-59	165.1(6.0)	167.6(5.6)	2.5	153.3(5.5)	155.1(5.4)	1.8
60-	164.8(9.6)	164.8(5.8)	0.0	153.2(5.2)	152.1(5.9)	-1.1
Body weight (kg)						
30-39	62.8(9.5)	72.3(10.7)	9.5	51.4(5.7)	57.4(9.1)	6.0
40-49	66.0(7.8)	70.0(9.4)	4.0	55.4(7.8)	58.3(8.4)	2.9
50-59	62.9(11.6)	68.5(9.4)	5.6	55.0(7.9)	58.4(7.7)	3.4
60-	61.1(9.1)	63.6(9.5)	2.5	56.7(8.5)	58.5(8.8)	1.8
BMI (kg/m^2)						
30-39	22.7(2.4)	24.3(3.1)	1.6	21.4(2.1)	22.5(3.4)	1.1
40-49	23.6(2.3)	24.3(2.9)	1.7	24.8(14.1)	23.5(3.1)	0.7
50-59	23.0(3.7)	24.3(2.9)	1.3	23.4(2.9)	24.3(2.9)	0.9
60-	23.0(3.1)	23.4(2.9)	0.4	24.1(3.4)	24.4(3.3)	0.3
Abdominal circumference (cm)						
30-39	77.7(7.1)	84.0(8.9)	6.3	73.9(6.0)	76.1(9.3)	2.2
40-49	82.8(5.9)	84.9(7.9)	2.1	84.2(6.4)	78.5(8.5)	-5.7
50-59	83.5(9.6)	86.5(8.2)	3.0	82.6(7.1)	82.3(8.6)	-0.3
60-	85.4(7.4)	85.4(9.1)	0.0	85.8(7.9)	84.3(9.5)	-1.5

Data are means (SD)
BMI: body mass index
Gap: SKS-NKRS

Comparison of the Mental Health Status Between NKRS and SKS

	Men			Women		
	NKRS(N=110)	SKS(N=220)		NKRS(N=330)	SKS(N=660)	
	% (n)	% (n)	p-value	% (n)	% (n)	p-value
Psychological stress			0.071			<0.001
Severe	43.0%(46)	30.0%(61)		54.3%(177)	28.3%(179)	
Moderate	47.7%(51)	55.7%(113)		39.3%(128)	60.7%(384)	
Mild	9.3%(10)	14.3%(29)		6.4%(21)	11.0%(70)	
Depression			<0.001			<0.001
Yes	41.3%(43)	12.3%(25)		46.2%(145)	15.8%(100)	
No	58.7%(61)	87.7%(178)		53.8%(169)	84.2%(533)	
Suicidal ideation			0.584			0.002
Yes	16.7%(17)	14.3%(29)		28.0%(85)	19.3%(122)	
No	83.3%(85)	85.7%(174)		72.0%(218)	80.7%(511)	
Suicidal trial			0.966			<0.001
Yes	13.3%(2)	13.8%(4)		30.1%(25)	6.7%(8)	
No	86.7%(13)	86.2%(25)		69.9%(58)	93.3%(112)	

Comparison of Prevalence of Several Lifestyle Related Diseases Between NKRS and SKS

	Male			Female		
	NKRS(%)	SKS(%)	p-value	NKRS(%)	SKS(%)	p-value
Hypertension	35.2	28.3	0.209	14.1	14.6	0.852
Diabetes mellitus	4.9	12.3	0.039	0.9	5.5	0.001
Dyslipidemia						
Hypercholesterolemia	12.8	13.2	0.917	5.8	8.4	0.164
Hypertriglyceridemia	10.8	26.9	0.001	7.3	7.5	0.936
Metabolic syndrome	20.8	24.8	0.445	15.3	17.5	0.395
Obesity	26.0	39.9	0.015	17.9	26.8	0.002

Data are %(n). p-values are based on chi-square test. NKRS, North Korean refugess; SKS, South Korean. Obesity was defined as BMI ≥25 kg/m².

Comparison of Prevalence of Each Components of MetS Between NKRS and SKS

	Men			Women		
	NKRS(%) (n=110)	SKS(%) (n=220)	p-value	NKRS(%) (n=330)	SKS(%) (n=660)	p-value
Abdominal obesity *≥90(M), ≥85(F)cm*	14.4	29.7	0.003	20.1	25.5	0.064
Blood pressure *≥ 130/85 mmHg*	48.5	37.1	0.007	23.2	18.8	0.034
FBG *≥ 100mg/dL*	27.5	32.3	0.383	19.6	21.7	0.445
Triglyceridemia *≥ 150mg/dL*	24.5	42.8	0.002	14.4	16.6	0.379
HDL cholesterol *<40(M),<50(F)mg/dL*	25.5	23.4	0.685	45.3	36.9	0.013
Metabolic syndrome	20.8	24.8	0.445	15.3	17.5	0.395

Comparison of Prevalence of Abdominal Obesity According to Age Between NKRS and SKS

age	Men			Women		
	NKRS % (n)	SKS % (n)	p-value	NKRS % (n)	SKS % (n)	p-value
30-39	5.6%(2/36)	31.8%(21/66)	0.002	5.3%(8/151)	18.6%(54/291)	<0.001
40-49	9.1%(3/33)	16.7%(9/54)	0.320	22.1%(21/95)	20.9%(37/177)	0.818
50-59	33.3%(4/12)	31.8%(7/22)	0.928	40.5%(15/37)	29.4%(20/68)	0.248
≥60	21.1%(4/19)	31.4%(11/35)	0.416	50.0%(18/36)	50.8%(32/63)	0.939

Data are %(n). p-values are based on chi-square test. NKRS, North Korean refugess; SKS, South Korean.

Comparison of Prevalence of MetS According to Age Between NKRS and SKS

age	Men			Women		
	NKRS % (n)	SKS % (n)	p-value	NKRS % (n)	SKS % (n)	p-value
30-39	14.3%(5/35)	16.7%(11/66)	0.755	6.6%(10/151)	7.6%(22/291)	0.718
40-49	12.5%(4/32)	14.8%(8/54)	0.765	12.6%(12/95)	12.4%(22/177)	0.962
50-59	33.3%(4/12)	27.3%(6/22)	0.711	33.3%(12/36)	26.5%(18/68)	0.462
≥60	22.2%(4/18)	25.7%(9/35)	0.780	37.1%(13/35)	47.6%(30/63)	0.317

Data are %(n). p-values are based on chi-square test. NKRS, North Korean refugess; SKS, South Korean.

Comparison of HOMA-β According to Age Between NKRS and SKS

	Men			Women		
age	NKRS	SKS	p-value	NKRS	SKS	p-value
30-39	79.2±40.8	117.4±38.4	0.001	92.2±36.3	136.6±68.2	<0.001
40-49	78.5±30.7	126.7±97.1	0.0079	88.7±73.8	125.9±58.2	<0.001
50-59	68.7±29.6	125.2±93.5	0.0785	87.3±44.4	107.9±52.3	0.0448
≥60	82.7±56.0	108.8±64.0	0.1423	105.0±80.8	112.3±54.6	0.5912

Data are means ± SD. p-values are based on t-test. NKRS, North Korean refugess; SKS, South Korean.

Logistic Regression Analysis for MetS According to Residence Period of NKRS

Residence period (month)	Prevalence % (n)	model1		model2	
		Odds ratio	95% CI	Odds ratio	95% CI
<24	14.4% (20/139)	1		1	
24-48	15.2% (21/123)	1.14	0.56-2.34	1.67	0.51-5.41
≥ 48	20.4% (28/137)	1.50	0.80-2.82	2.24	0.75-6.64

Model 1; adjusted for age and sex
Model 2; Model 1 + smoking status, alcohol intake, exercise and income, education level

Logistic Regression Analysis for MetS According to Weight Changes of NKRS

Weight change	Prevalence % (n)	model1		Model2	
		Odds ratio	95% CI	Odds ratio	95% CI
No increase	14.2% (22/155)	1		1	
< 5%	14.6% (18/123)	1.08	0.53-2.18	3.24	1.02-10.28
≥ 5%	23.6% (25/106)	2.08	1.05-4.12	9.34	2.87-30.40

Model 1; adjusted for age and sex
Model 2; Model 1 + smoking status, alcohol intake, exercise and income, education level

Let's Focus More on Weight Change in South Korea

Group and Abbreviation

3 group

- I : -5% > weight change (weight loss)
- II : -5% ≤ weight change <5% (weight maintain)
- III : 5% ≥ weight change (weight gain)

Abbreviation

- In_Weight: Initial weight on arrival in Korea
- In_BMI: Initial BMI on arrival in Korea

Clinical Characteristics According to Weight Change in South Korea (1)

	Groups according to weight change in South Korea			
	I	II	III	P for trend
No.	70	281	143	
Sex (M/F)	15/55	62/219	34/109	0.701
Age	43.4±12.1	44.1±11.0	43.6±10.4	0.921
Height	156.1±8.0	156.9±7.1	158.3±7.8	0.038
Weight	52.3±7.7	55.9±8.3	58.6±9.1	<0.001
In_Weight	58.1±9.0	55.5±8.2	52.0±7.7	<0.001
BMI	21.4±2.7	22.6±2.8	23.3±2.5	<0.001
In_BMI	23.8±3.3	22.5±2.7	20.7±2.3	<0.001
WC	76.5±7.4	78.9±8.3	81.0±7.6	<0.001
SBP	114.4±22.5	118.7±17.2	120.7±15.7	0.015
DBP	72.7±13.8	75.5±13.2	77.8±13.5	0.010
FBS	91.8±8.0	92.9±11.3	93.8±10.0	0.21

In_Weight: Initial weigh on arrival in Korea, In_BMI: Initial BMI on arrival in Korea

Clinical Characteristics According to Weight Change in South Korea (2)

	Groups according to weight change in South Korea			
	I	II	III	P for trend
TC	170.1±34.6	173.9±34.2	177.07±38.8	0.194
TG	93.2±59.6	100.2±71.6	120.9±156.8	0.065
HDL	53.1±12.6	52.8±12.9	51.8±11.5	0.473
AST	20.0±5.6	20.3±7.1	21.1±7.9	0.31
ALT	16.2±7.4	17.5±11.0	19.7±13.6	0.037
GGT	20.4±14.5	25.9±33.9	31.2±36.5	0.024
Alb	4.37±0.23	4.37±0.23	4.36±0.21	0.817
hsCRP	0.81±1.3	0.88±1.4	1.04±1.62	0.283
MS (%)	7	18	23	0.016

Adjusted Odds Ratios for Components of MS Regarding to Weight Gain in South Korea (Model I)

	II	III
	OR(95% CI)	OR(95% CI)
Waist circumference ≥ 90cm (men), ≥ 85cm (women)	2.59(1.02-6.61)*	4.34(1.63-11.52)*
Elevated BP ≥ 130/85 mmHg	1.74(0.88-3.43)	1.84(0.89-3.80)
Elevated glucose ≥ 100mg/dL	1.27(0.60-2.67)	2.13(0.90-4.63)
Elevated triglyceride ≥ 150mg/dL	1.50(0.66-3.41)	1.78(0.74-4.24)
Reduced HDL cholesterol < 40mg/dL (men), < 50mg/dL (women)	1.06(0.62-1.84)	0.90(0.49-1.64)
Metabolic syndrome	2.17(0.81-5.84)	3.25(1.17-9.06)*

Model 1: Adjusted for age, sex

Adjusted Odds Ratios for Components of MS Regarding to Weight Gain in South Korea (Model 2)

	II	III
	OR(95% CI)	OR(95% CI)
Waist circumference ≥ 90cm (men), ≥ 85cm (women)	2.06(0.64-6.64)	4.44(1.24-15.94)*
Elevated BP ≥ 130/85 mmHg	1.81(0.73-4.49)	1.45(0.53-3.96)
Elevated glucose ≥ 100mg/dL	1.82(0.58-5.75)	3.96(1.20-13.04)*
Elevated triglyceride ≥ 150mg/dL	0.79(0.28-2.26)	1.27(0.42-3.82)
Reduced HDL cholesterol < 40mg/dL (men), < 50mg/dL (women)	0.87(0.41-1.84)	0.79(0.35-1.83)
Metabolic syndrome	2.22(0.57-8.68)	4.43(1.09-18.12)*

Model 2: Model 1+ alcohol intake, smoking, exercise, income, education

Prevalence of Excess Weight Gain (≥5%) According to In_BMI Group

	Underweight (BMI ≤18.5)	Normal weight (18.5<BMI<23)	Overweight (BMI≥23)
No.	34	284	164
5% ≤ Weight gain (%)	68%†	32%†	15%†
Weight gain (kg)	8.1±6.4*	6.6±3.8*	5.6±2.9*
Current weight (kg)	52.5	58.3	68.1

In_BMI: Initial BMI on arrival in Korea, †p<0.001, *p=0.047

Adjusted Odds Ratios of Excess Weight Gain (≥5%) According to In_BMI Group

	Overweight (BMI≥23)	Normal weight (18.5<BMI<23)	Underweight (BMI ≤18.5)
		OR(95% CI)	OR(95% CI)
5% ≤ Weight gain	1	2.58(1.57-4.23)	11.63(5.04-26.80)

An Analysis in Subjects with MetS According to In-BMI Group

	Underweight /normal weight	overweight	P for trend
No.	37	45	
Res. dur. (yr)	3.6±3.1	3.3±3.2	0.667
Sex (M/F)	12/25	7/38	0.073
Age	49.5±11.9	49.7±10.7	0.944
Height (cm)	159.5±8.2	156.2±6.8	0.049
Weight (kg)	58.3±9.7	64.5±7.5	0.002
ln_Weight (kg)	53.0±6.6	63.6±7.3	<0.001
BMI (kg/m^2)	22.8±2.1	26.4±2.2	<0.001
ln_BMI (kg/m^2)	20.8±1.8	26.0±2.4	<0.001
WC (cm)	81.5±7.0	89.8±6.1	<0.001

The Difference in Prevalence of Metabolic Components According to In-BMI Group - An Analysis in Subjects with MetS

	Underweight Normal weight	Overweight
No.	37	46
Waist circumference ≥ 90cm (men), ≥ 80cm (women)	54%*	87%*
Elevated BP ≥ 130/85 mmHg	68%	63%
Elevated glucose ≥ 100mg/dL	68%†	46%†
Elevated triglyceride ≥ 150mg/dL	62%	59%
Reduced HDL cholesterol < 40mg/dL (men), < 50mg/dL (women)	54%	87%

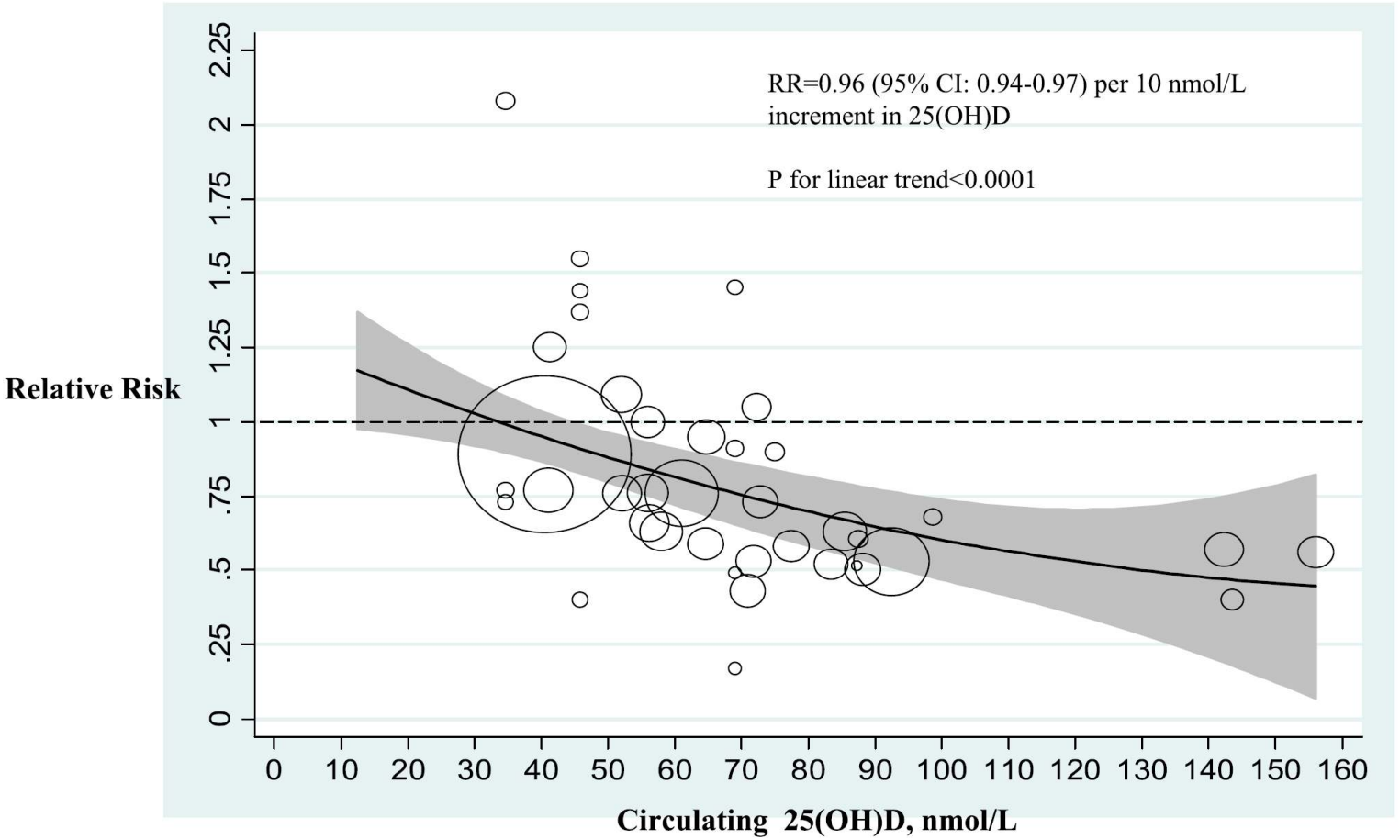
* P=0.001, †P=0.047

Odds Ratios for Prevalence of Metabolic Components According to In-BMI Group - An Analysis in Subjects with MetS

	Overweight	Underweight
No.	46	37
Waist circumference ≥ 90cm (men), ≥ 80cm (women)	1	0.18(0.06-0.52)*
Elevated BP ≥ 130/85 mmHg	1	1.22(0.49-3.04)
Elevated glucose ≥ 100mg/dL	1	2.48(1.01-6.10)*
Elevated triglyceride ≥ 150mg/dL	1	1.16(0.48-2.80)
Reduced HDL cholesterol < 40mg/dL (men), < 50mg/dL (women)	1	0.54(0.17-1.74)

Vitamin D Levels in NKRs
- A Pilot Data

Relation Between the Risk of Type 2 Diabetes and Baseline Levels of 25(OH)D in 18 Independent Prospective Studies Included in The Meta-analysis



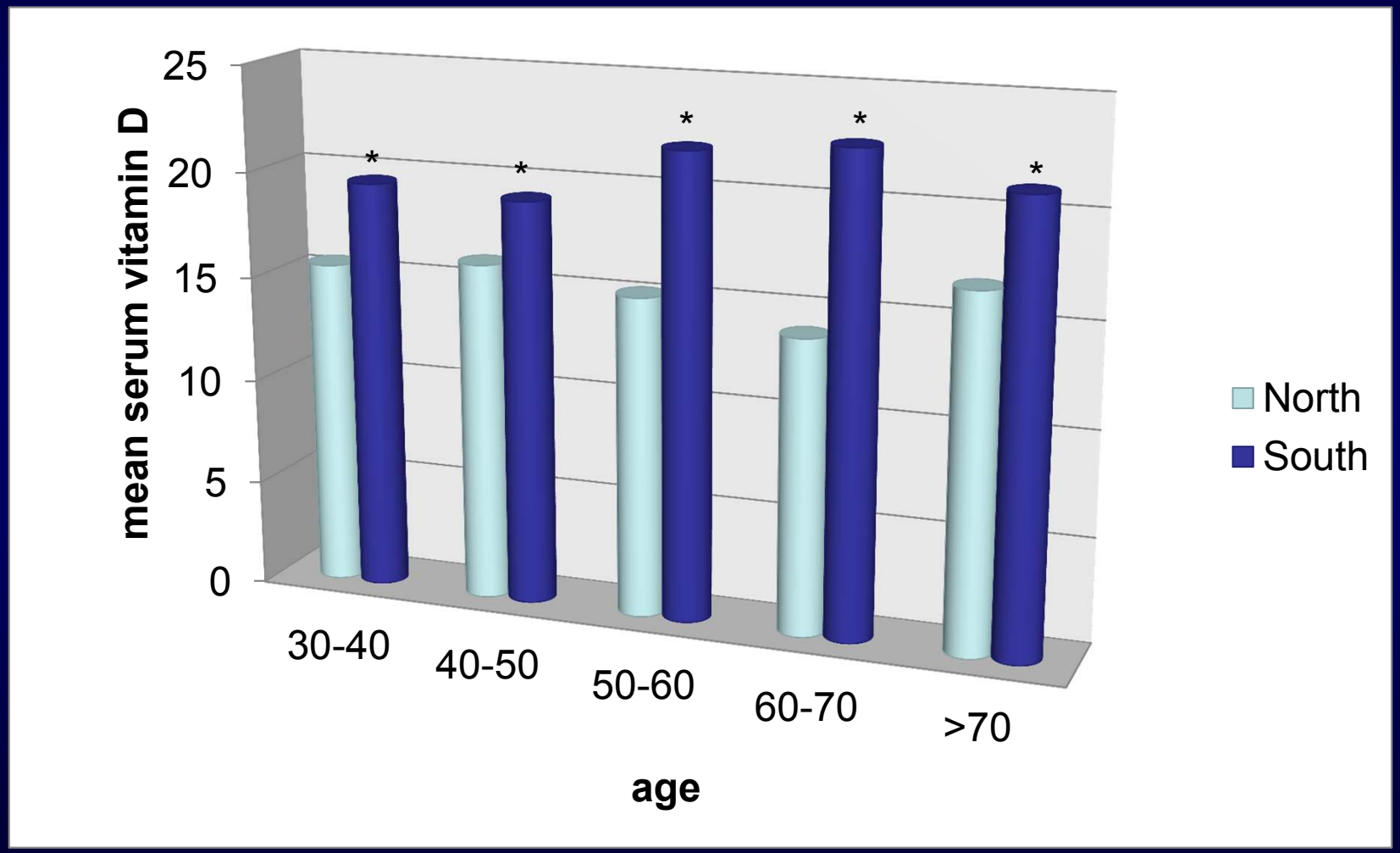
Diabetes Care 36:1422–1428, 2013

Prevalence of Vitamin D Insufficiency in NKRs and SK

- 2:1 matching of age and sex
- North Korean Refugees: 379 (82 male, 297 female)
- South Koreans: 758 (164 male, 594 female) from KNHNES
- Deficiency < 20 ng/mL (87% vs 57%), Insufficiency ≥ 20 ng/Ml, < 30 ng/ml (13% vs 32%)

	Vitamin D category (ng/ml)				
	< 10	10-20	20-30	≥30	P
North Korean Refugees	36/386 (9.3%)	300/386 (77.7%)	50/386 (13.0%)	0/386 (0.0%)	<0.001
South Koreans	72/713 (10.1%)	336/713 (47.1%)	227/713 (31.8%)	78/713 (10.9%)	

Mean Serum Vitamin D Levels by Age - Comparison Between NKRs and SK

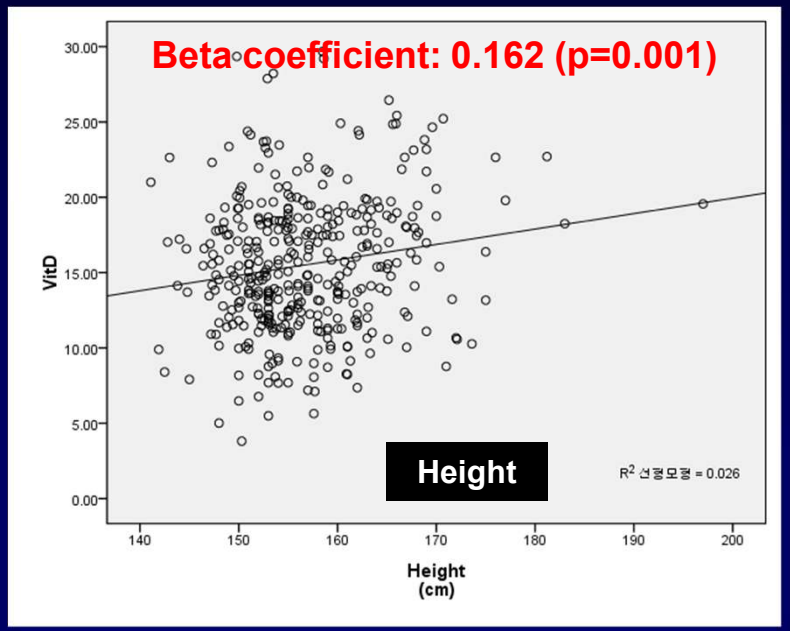


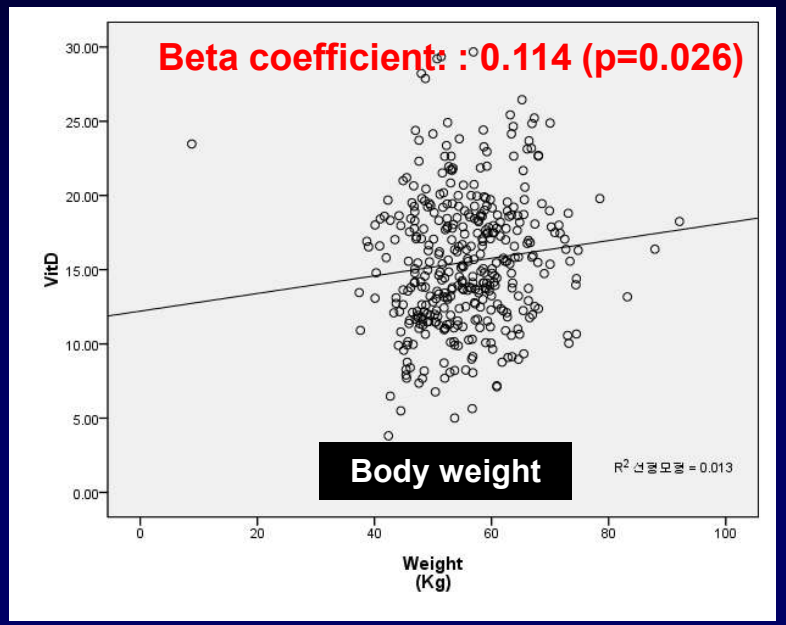
*Statistically significant in all age group

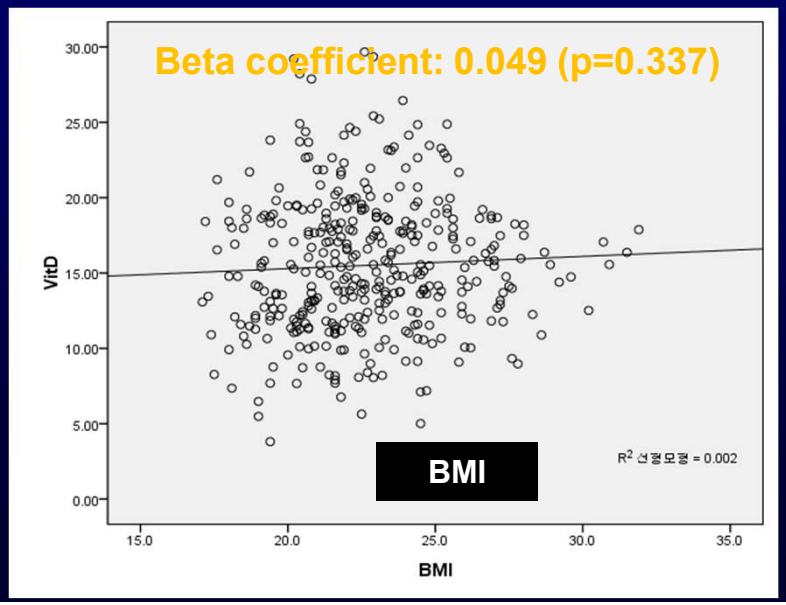
Vitamin D Status, Mets and Its Components

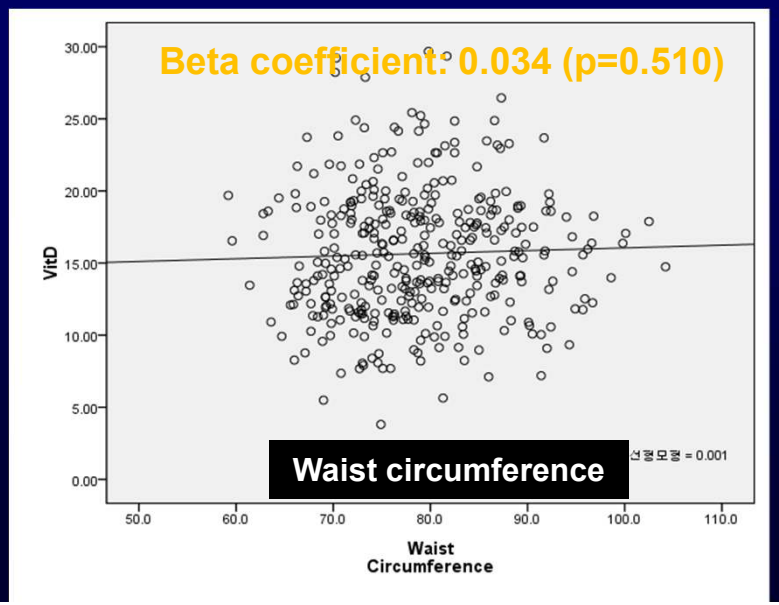
	High BP	Hyperglycemia	Hypertriglyceridemia	WC	HDL	Metabolic syndrome
Vitamin D >20 ng/mL	7/46 (15.2%)	9/46 (19.6%)	12/50 (24%)	11/50 (22%)	18/50 (36%)	9/50 (18%)
Vitamin D < 20 ng/mL	79/328 (24.1%)	79/322 (24.5%)	122/336 (36.3%)	115/335 (34.3%)	145/333 (43.5%)	85/336 (25.3%)
P-value	0.18	0.26	0.46	0.08	0.31	0.26

Relationship Between Vit-D Level and Various Anthropometric Data









Summary & Implication (1)

- The **prevalence of MetS** in this study population was 20.8% in men and 15.3% in women, and was **similar** compared to that of SKS.
- In spite of relatively low prevalence of overall and abdominal obesity, **metabolic derangement was not mild in NKRS** relative to SKS.

Summary & Implication (2)

- Odds ratio of MetS in case of **weight gain more than 5%** versus no change of weight **during the residence period** in South Korea was 9.34 (p-value <0.001) after adjusting for various confounding factors.
- Divided according to initial BMI on arrival in South Korea, **underweight refugees experienced more weigh gain (≥ 5%)** compared to normal weight or overweight (68%, 32%, 15%, respectively)

Summary & Implication (3)

- Among **NKRS with MS**, **underweight or normal weight initially on arrival** to South Korea showed **more risk for IFG** (OR 2.5) compared to overweight despites of low risk for abdominal obesity.
- All NKRS showed **vitamin D deficiency** or **insufficiency**.
- On the other hand, **the prevalence of diabetes** in NKRS was only 4.9% in men and 0.9% in women.

Summary & Implication (4)

- The **MetS, IFG** and **low vitamin-D level** are **well-known risk factors for diabetes.**
- Additionally, the level of **HOMA-β** is very low in NKRS especially in 30-49 aged group.
- So, this analysis indicates that **the prevalence of diabetes may rapidly increase in a short period**.
- It may be possible that the prevalence of MetS and diabetes in NKRs will exceed that of SK in the future.

Conclusion

- **The potential disease burdens of CVD and diabetes mellitus in NKRs** could be **substantial because of the inherent metabolic vulnerability** of NKRs.
- When considering the high burden of CVD and diabetes mellitus in South Korea, the morbidity and mortality due to these notorious diseases in NKRs are expected to increase with **the length of stay** and **the extent of acculturation** in South Korea.

‘South Koreanization’ characterized by Westernization is not always good for NKRs.

A healthy life-style is extremely important especially in high risk groups such as NKRs for life-style related disease.

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Thank you for your attention!