AnnalsofClinicalandMedical Case Reports

Review Article ISSN2639-8109Volume9

HeightisaMeasureofConsumptionthatIncorporatesNutritionalNeeds:Whenand What?

HiroshiMori*

SenshuUniversity,Chiyoda-ku,Tokyo,Japan

***Correspondingauthor:**

Hiroshi Mori,

ProfessorEmeritus,SenshuUniversity,Tokyo,

E-mail: hymori@isc.senshu-u.ac.jp

Received: 07 Sep 2022

Accepted: 15 Sep 2022

Published:20Sep2022

JShort Name:ACMCR

Keywords:

Children;Height;Japan;SouthKorea;Food consumption by age; Essential nutrients

Citation:

HiroshiMori,HeightisaMeasureofConsumptionthat IncorporatesNutritional Needs:When andWhat?. Ann Clin Med Case Rep. 2022; V9(14): 1-8

1. Abstract

Japan suffered heavily from WWII. Per capita food supply was 1,450 and 1,700 kcal/day in 1946 and 1947, respectively. Japan's economy quickly recovered to the pre-war level in 10 years after the war, 2,200 kcal/day in average food supply in 1955, making steady progress toward the end of the century. People in Japan, the younger generations, in particular, learned to eat more animal productsandchildrenstartedgrowingtallerinheight.SouthKorea followed suit, about two decades behind Japan, due to the Korean War (1950-53). Despite increasing supply of animal protein, childreninJapanceasedtogrowanytallerinheightattheend of the 1980s, while Korean youth kept growing taller to overtake Japanese peers by 3 cm in mean height of late adolescents in the mid-2000s and then stopped growing any taller: hitting "gene potentialsinreserve"?TheyounginJapanstartedtoturnawayfrom fruit in the end of the 1970s, eating less than 5% of the consump- tion by adults in their 50-60s at the end of the 2000s. Children in South Korea started to turn away from vegetables (e.g. Kimchi)in the early 1990s, eating less than 10% of the vegetables eatenby the older generations in their 50-60s at the end of the 2010s. Blumsuspectsthatahighconsumptionofanimalproteindoesnot resultinincreasingbodyheight,ifconsumptionofotheressential nutrients is insufficient.

2. IntroductionandData

Steckel states, "stature is a measure of consumption that incorporatesoradjustsforindividualnutritionalneeds;itisanetmeasure that captures not only the supply of inputs to health but demands ontheseinputs"(RichardH.Steckel,1995,p.1903)[1].Inhuman biology, it is widely conceived that "first years of life", or first 1,000days,includingpregnancyshouldbecrucialfordetermining futureadultheight[2-4].Coleetal.conclude,"mostoftheheight increments seen in adults had already accrued by the age of 1.5 years," analyzing fifty years of data in Japan and South Korea by SITAR [5]. The author, based on his own personal observationsof college students in and soon after the war, the 1940s and the early 1960s, suspects that children may have chances to catch-up fromseverestarvationduringinfancyevenaftertheyhavereached adolescence. He and his associates in a noted university inTokyo in the early 1960s noticed that their students were apparently 2-3 cm taller in mean height than their professors in their 30s (Table 1).The author and his colleagues were born in the late 1920s and the early 1930s, when the food supply was plentiful, if not highin quality, but spent long, very hungry days in their middle-high schoolanduniversityyears.Ontheotherhand,theirstudentswere bornandspenttheirinfanciesinthemidstofthewarshortagesbut ate more foods and better diets in their early and late adolescence (Table 2).

It is widely held that increases in supply/consumption of animal protein should result in taller height of individuals and or populations, as partly observed above. Blum, a biological historian in Europe, put forth the reservations that a high consumption of animal protein alone does not result in increasing body height, if the overallconsumptionofcaloriesandotheressentialnutrientsisinsufficient[6].Observingsecularchangesinheightofyoungadults in several countries in SoutheastAsia in the past half century, the authorcametoagreewithBlum,althoughhefailedtopinpoint

what"otheressentialnutrients"couldbe,whilediscountingethnic differences(Mori,2022)[7].Theauthorlearnedin2016thathigh schoolseniorsinSouthKoreaceasedtogrowtallerinheightinthe mid-2000s(*ChosunIlbo*,2016)[8].Japaneseyouthshadplateaued in height 15 years earlier at the end of the 1980s. The differences are that Japanese high school seniors were a few cm taller than their Korean peers in the 1970s, who kept growing taller steadily fasttocatch-upwithJapaneseinthemid-1990sandovertookthem by3.0cminthemid-2000s(Figure1).Someanthropologists,quite likelymost,particularlyinKorea,tendtoattributethesedifferenc- es to ethnicity [9]. However, for just example of the difficulty of attributingheightdifferencestoethnicity,notethatthattheDutch are the world's tallest, 2 cm taller than Norwegians in the end of thelastcentury,whohadlongbeenafewcmtallerthantheDutch sincethemid-19thcentury(Figure2).Malesdonotgrowanytaller in height after the age of 20 years old.Asians, either Japanese or Koreans,tendtostopgrowingtallerinheightbeforetheageof20, 1 or 2 years earlier than Northern Europeans. Japan has two offi-cialdatasourcesforheightbyage:*NationalHealthandNutrition Surveys* [10], since 1948 and *School Health Examination Surveys* [11],whichcoverschoolchildrenfrom1stgradeinprimaryschool, 6yearsofagetoseniorgradeinhighschool,17yearsofagesince 1900.An equivalent Health and Nutrition Survey was conducted in1998forthefirsttimeinSouthKorea,followedbythe2ndonein 2001andthe3rdonein2005[12].Theauthorhasaccesstocompa-rable*KoreanSchoolHealthSurveys*[13]everyyearsince1961.In conductingcomparativeanalysesofchildren'sheightinJapanand South Korea, School Health Surveys have been and will be used, despitesomelimitationsthatearlyyearsoflife,fromzeroto5and the late adolescent years are not available.

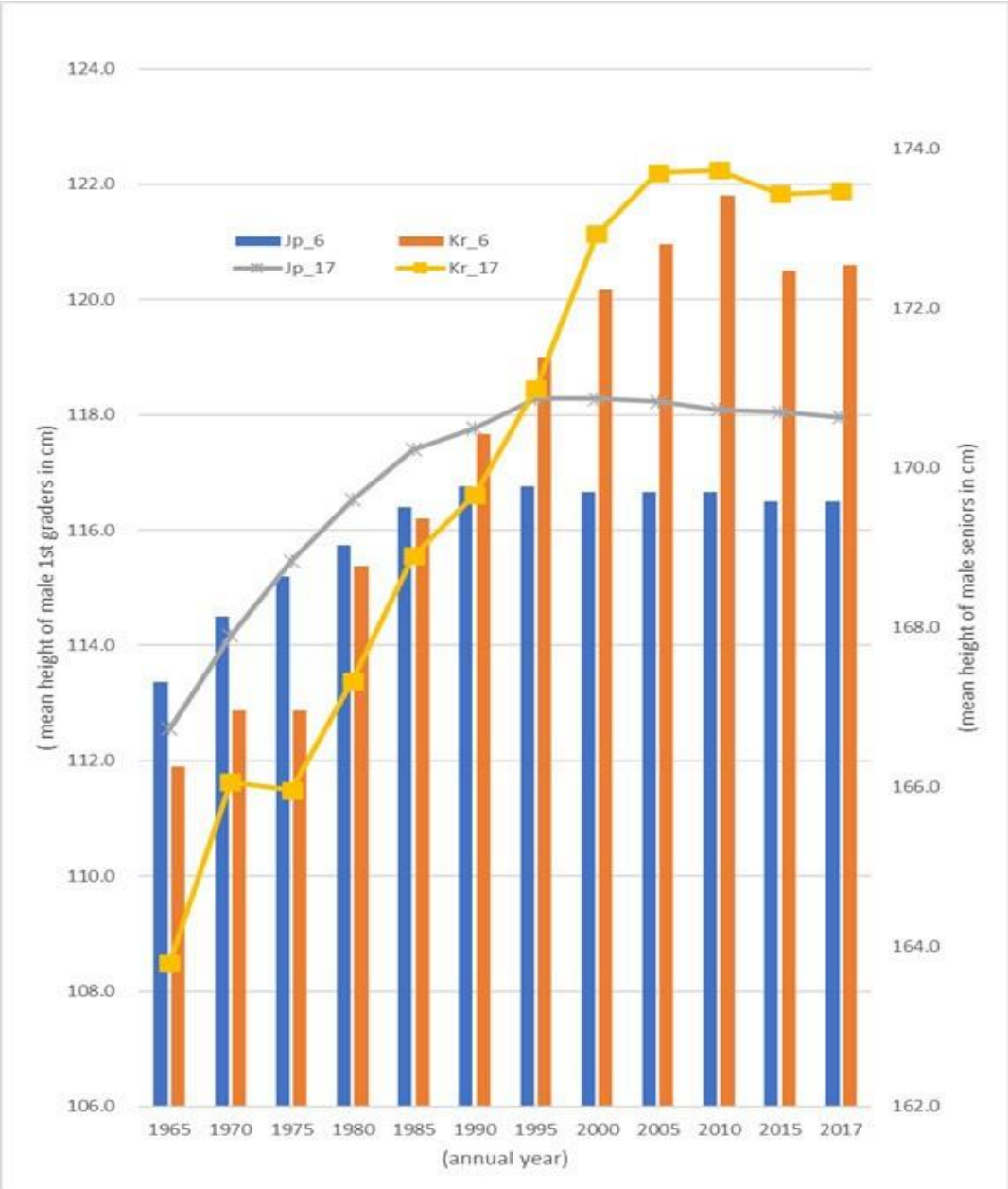

Figure1: Changesinmeanheightofmale1stgradersinprimaryschool(6yr)andmalehighschoolseniors(17yr)inJapanandSouthKorea,1965to 2017

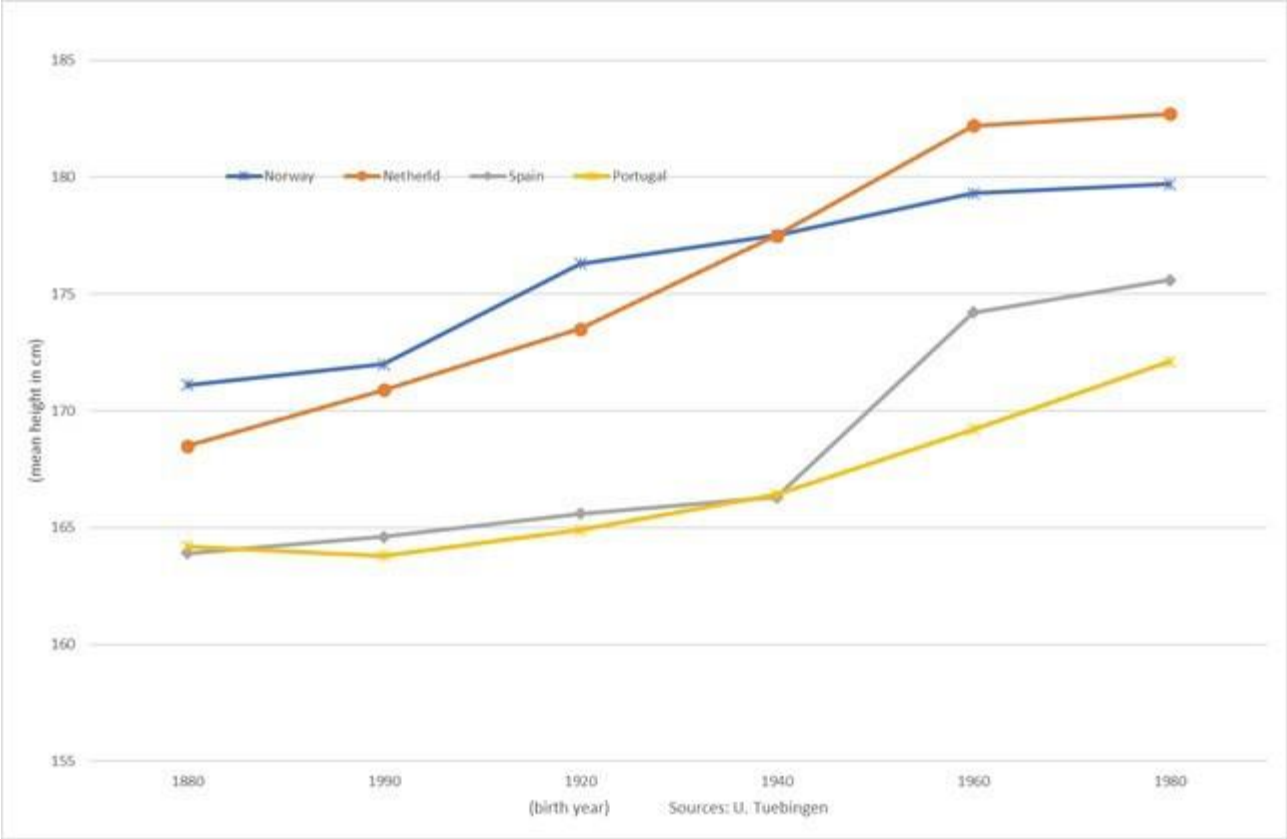

Figure2: Secularchangesinmeanheightofyoungmenbybirthyear,Netherlands,Norway,SpainandPortugal,1880to1980

Table1: MeanheightofJapaneseMalesbyage,1948-50~1962-64

age	sample*	1948-50	1958-60	1962-64
10	453	126.3	130.6	132.2
11	444	130.5	135.2	137.0
12	423	135.2	140.2	142.9
13	384	140.4	147.0	150.3
14	363	145.8	153.2	156.4
15	375	151.4	158.1	161.2
16	362	155.6	160.6	163.5
17	297	158.5	162.8	164.6
18	315	160.2	162.6	164.5
19	275	160.9	163.0	164.7
20	282	161.3	162.0	164.4
26 ~ 30	837	161.0	162.0	163.3
31 ~ 40	1739	160.3	161.6	162.5

Sources:NutritionSurveys[10],variousissues,incm. Note: *
# of samples, 1948, for example.

Table2: ChangesinpercapitaDailyCaloricSupplyfromSelectedFoodsinJapan,1930to1990-99,kcal/day

	Total	Grains	Meats	Fish	Milk	Veges
1930-34	2067	1501	6.8	65.2	4.4	50.4
1935-39	2059	1486	8.0	63.6	5.6	50.6
WARS						
1946	1449	1112	3.0	36.0	4.0	36.0
1947	1695	1390	4.0	37.0	4.0	38.0
1948	1851	1440	4.0	41.0	4.0	40.0
1949	1927	1483	6.0	53.0	7.0	42.0
1950	1945	1527	8.0	71.0	9.0	44.0
1951	1858	1356	11.7	50.6	9.4	68.6
1952	1995	1376	14.8	61.2	13.6	67.7
1953	1933	1323	15.6	57.1	13.6	59.3
1954	1951	1336	16.7	58.7	18.2	58.8
1955	2217	1478	16.8	83.5	19.5	72.9
1957	2270	1511	22.5	91.7	26.1	75.6
1960	2385	1429	42.2	91.8	52.9	91.9
1965	2444	1334	61.6	92.2	69.9	93.0
1970-74	2492	1209	91.3	96.4	83.0	92.2
1975-79	2545	1154	123.3	127.2	97.4	80.7
1980-89	2624	1086	143.5	131.3	112.4	81.2
1990-99	2635	1039	144.4	139.4	133.1	86.3

Sources:Minister'sSecretariat,BasicStatisticsonFoodDeamand,Tokyo,NorinTokeiKyoukai,1976.Kayo, N.BasicStatisticsforJapanAgriculture,Tokyo,Norin-TokeiKyoukai,1977[22,Chap.8].

3. Discussions

Theauthorhasanalyzed,incollaborationwithafewstatistics-oriented researchers, secular changes in children's height, mostly malestudents[*1],inthepasthalfcenturyinJapanandSouthKorea, mainly from the perspectives of food consumption. As the economy progresses, people tend to eat more animal products, which results in taller height. This took place steadily in the post-war Japan and South Korea, with the latter two decades behind the former due to the Korean war (1950-53), as clearly demonstrated byTable3.Whenmeanheightofmalehighschoolseniorstudents isregressedagainstpercapitasupply/consumptionofanimalproducts,eitherintermsofkcal(calories)orgramsofprotein,fromthe mid-1960s to 2010 (3 year moving averages every 5-year period, FAOSTAT, *Food Balance Sheets* [14]), nearly perfect statistical fits are obtained, showing the dominance of animal protein in determining height of children.

H_{jp_17}=162.4+0.155Anim-prodprotein(1)
(240.6)(11.0) Adj. R^2=0.93

H_{kr_17} = 162.6 + 0.265Anim-prod protein (2)
(336.1)(15.4) Adj. R^2=0.96

Where,

H_{jp_17}:meanheightofmaleseniorstudents inJapan

H_{kr_17}:meanheightofmale seniorstudents inSouthKorea

Anim-prod protein: supply of protein from animal products (gr/capita/day)

Figuresinparenthesesdenotet-values

No one would question the dominant importance of animal protein for developing human height. Table 3, however, shows that Japan's per capita supply of animal protein was far greater than South Korea's in the 1990s, but Korean children kept growing taller at a rapid pace. In the mid-2000s, when Japanese children were overtaken by their Korean peers by 3 cm in height, Japan still exceeded Korea considerably in respect of supply of animal products.Attributingthesedifferencestoethnicityisjusttoosim- ple. In the presence of age and cohort effects, simple per capita consumption,derivedfromFoodBalanceSheets,mightmisrepresentsecularchangesinconsumptionbychildreningrowingages. ChildrenincountryAmayconsumealotmoremeatthantheolder adult population, whereas the older generations in country B may consumesubstantiallymorefishthanchildren,theyoungergenerations,forexample.Indiscussingcomparativechildren'sgrowth ofheight,itisdesirabletocomprehendconsumptionpatternsof foodgroupsbyagegroups,inplaceofsimplepercapitaconsumption of populations.

[*1]Lessthanhalfoffemalegraduatesfromjuniorhighschoolswent into senior high schools before the 1970s, particularly in South Korea.

Table3: Changesinpercapitasupplyofanimalproductsandprotein from animal products, Japan and South Korea, 1965 to 2010

3 yr avr	Jp_kcal/d	Kr_kcal/d	Jp,g/cap	Kr,g/cap
1965	324	71	28.6	6.9
1970	426	108	36.3	8.6
1975	474	170	41.6	14.6
1980	539	230	46.9	18.5
1985	577	275	50.9	23.0
1990	618	317	55.2	26.6
1995	624	411	56.1	33.8
2000	600	449	55.0	36.8
2005	578	475	51.3	39.0
2010	549	545	48.6	44.0

Sources: FAOSTAT, Food Balance Sheets, 1961-2013[14].
Notes:3yearmovingaverages,like1970=average(1969-1971).

4. FoodConsumptionbyChildreninGrowingAges

Nearly 3 decades ago, Japanese government *White Paper on Agriculture-1994* [15] attempted to draw public attention to "*wakamono no kudamono-banare*"(steering away from fruit by the young).The dataused were simple. Based on *Family Income and Expenditure Surveys* [16], classified by age groups of household head (HH), households headed by the younger age groups, were purchasing substantially less fresh fruit than the older households in the 1980s, without identifying age and cohort (generation) effectsofindividualhouseholdmembers.The*Paper*failedtoattract wide interests from agricultural economists, who remarked that the young people have been simply shifting from fresh fruits tobe peeled to juice which requires no knives [17].Actually, fewer Japanesenowbrewleaftea,buyingbottledtea.Theyoungerones areinvolvedin"pot-culture",inparticular(*Decliningorangeconsumption in Japan*, ERS/USDA, 2009 [18]). Students buy bottled water,insteadofdrinkingfreetapwateronthecampusorathome.

However, based on Japan Soft Drink Manufacturers Association *Annual Reports* [19], fruit juice, including drinks hit the peak in total production in the late 1980s. The author and his associates designed robust econometric model, which derives per capita consumption of selected commodities by individual household members by age, including children, from *FIES* annual reports, classified by HH age groups [20,21,18]. Not only estimating individual at-home consumption by age, including non-adult members,theyidentifiedage/period/cohorteffectsformajorfoodsand food groups for the past 30 to 40 years. Except for milk, pure age effectsprovedthehighestfortheyoungadults,graduallydeclining toward the elderly. Importantly, cohort or generational effects have proved quantitively significant in determining individual householdconsumptionofmostfoodproducts[22].Tables4and5provide changes of individual household consumption of fresh fruit andfreshvegetablesbyagegroups,0~9,10~19,20~29,---,50~59, 60~69, 70~, from 1971 to 2010, nearly every 10 years, estimated by the author. "*Wakamono no kudamono-banare*" is very clearly demonstrated in Table 4. Traditionally, people in Japan eat more fruit than Koreans, while the latter eat more vegetables than the Japanese(Table6).Inthemid-1990s,however,Japanwasfarbe- low South Korea in per capita supply of vegetables and exceeded by South Korean levels by 25% in respect of per capita fruit consumption.Intheearly1970s,Japanesechildren,0~19yearsofage, consumed 40 kg of fresh fruit at home, about the same amount as the grown-up adults. Children began to eat less and less fruit at home,whiletheolderadultsintheir50skepteatingslightlymore than 50 kg per capita/year until the mid-1990s.

In1990,childrenunder10yearsofageate10kgoffruit,lessthan 20%,comparedtothoseintheir40sto60s.In2000,childrenunder 20 ate only 5kg/year, or less, per capita, only 10% of the amount offruit,consumedbytheolderadults.Youmaynotbeexaggeratingtoconcludethatmost Japanesechildrenhavequiteatingfresh fruit at every day household dining tables. Not to the extent of freshfruit,childreninJapanhavebeenturningawayfromvegetablessincetheearly1980s(Table5).NationalFruitTreeResearch Institute, in collaboration with Hamamatsu School of Medicine, has been conducting longitudinal studies, Mikkabi-machi Cohort Projects,toseeifconsumingreasonableamountsoffruitregularly would contribute to reducing risk of bone loss and osteoporosisin post-menopausal female subjects [23-26]. The studies refer to the related empirical research projects in other countries, which confirmthepositiverelationsbetweenbonemineraldensitiesand consumptionoffruitandvegetablesamonggrowingchildren[27-30].KoreanshavebeenknownforKimchi.Japaneseeatabowlor bowls of rice with a few pieces of *tsukemono* (pickles), whereas Koreans eat lots of Kimchi, with rice or noodles. By courtesy of Dr. Sanghyo Kim, KREI [31], the author obtained *Household IncomeandExpenditureSurveys*[32],StatisticsKorea,everyissue from 1990 to 2019. Like *FIES*, Japan, *HIES* provides household expenditures, classified by HH age groups, with supplementary age structure of households by HH groups. Expenditure items are verybroad,suchasmeatandprocessedmeat,notbrokenintobeef, pork, etc. and provided in current Wons, neither in kg nor unit prices. With the exact information of household age structure by HHagegroups,however,itprovedeasyfortheauthortoderiveindividualconsumption(inexpenditures)byhouseholdmembersby age,includingchildren.Table7summarizeschangesinpercapita consumption(intermsofrelativepurchasedvalues)ofvegetables byagegroupsinSouthKoreainthelatest30years,1990to2019. The author would often hear from his Korean colleagues in their 50-60s that students in these days do not care for Kimchi, which should be high in nutrition. Observing students in the university cafeteriasintheauthor'scountry,hehasconceivedthattheKorean students ate a lot more vegetables, both in quantity and variety, thantheirJapanesepeers.Theauthorwasstunnedtorealizethat

children's individual consumption of vegetables has steadily declinedinthepastthreedecadestonearlytheone-tenthofwhatthey used to eat in the beginning of the 1990s in terms of relative per capitaexpendituresbythosemiddle-agedadultsintheir50s[*2].Itis equivalentto*wakamononokudamono-banare*whichtookplacein the three decades since the early 1970s in Japan, which may have resultedinplateauingofchildren'sheightinthe1990s.Theauthor hasfourgrand-children,oneofwhomisaboy,181cmandtherest are girls, close to 165 cm in height. None of them are abnormally tall. "Gene potential in reserve" (Kopczynski, M[9]) should not be applied too easily (Mori, "Review", 2022[33]).

[*2]Korea's*HIES*providesexpendituresincurrentWons,withnei- ther unit prices nor quantities, unlike Japan's *FIES*. Expenditures on vegetables include processed vegetables, such as Kimchi, purchased in super markets and local specialized stores.

Table4: Changesinpercaptaat-homeconsumptionoffreshfruitbyagegroups,1971to2010,Japan(kg/year)

	1971	1980	1985-86	1990	1995-96	2000	2008-10
0~9	36.3	26.5	15.2	8.9	4.7	2.3	3.0
10~19	45.6	30.5	20.1	14.9	9.4	5.7	4.7
20~29	48.3	31.5	23.4	16.8	15.1	11.8	10.5
30~39	46.1	43.8	36.6	30.4	23.6	21.8	16.4
40~49	51.0	52.6	48.5	44.9	37.2	33.4	22.6
50~59	54.4	59.9	56.6	54.0	50.5	48.5	36.4
60~	42.9	56.4	60.4	61.2	60.4	63.3	57.1
Grand-ave	45.6	41.6	36.4	33.8	31.5	31.1	28.9

Sources:derivedbytheauthor fromFIES[16],variousissues,theTMI model.

Table5: Changesinpercapitaat-homeconsumptionoffreshvegetablesbyagegroups,1971to2010inJapan(kg/year)

age/year	1971	1980	1985-86	1990	1995-96	2000	2010
0~9 yo	44.8	33.7	27.3	23	20.2	18.3	17.5
10~19	62.2	51.1	44.7	38.8	36	30	30.6
20~29	67.8	56.1	52.5	45.5	46.2	40.8	37.6
30~39	68.5	65.6	60.2	54.3	52.3	49.8	45.7
40~49	77.4	80.3	78.2	71.7	67.3	62	54.7
50~59	89	90.5	91.9	84	83.7	82.3	66.2
60~69	87.5	93.3	99	91.2	91	94	80.8
70~	71	80	89.4	80.1	81.3	86.9	81.5
Grand ave.	67.1	63.6	62.4	58.3	59	57.2	55.4

Sources:derivedbytheauthor fromFIES[16],variousissues,theTMI model.

Table6: PercapitasupplyofvegetablesandfruitinJapanandsouthKorea,1970to2010

	Vegetables		Fruit	
Year	Japan	S. Korea	Japan	S. Korea
1970	129	107	53	12
1980	123	206	57	25
1990	117	196	50	53
1995	116	213	52	65
2000	113	230	53	69
2010	100	212	51	69

Sources:FAOSTAT,FoodBalanceSheets[14],oldmethodologies

Notes: every year represents 3 year moving average, kg/year.

Table7: Changesinpercapitahouseholdexpenditureson vegetablesbyagegroups,1990to2019,S.Korea(%ofthe 50's)

age group	1990-91	1995-96	2000-01	2005-06	2010-11	2014-15	2017-19
0-9	49.8	31.4	30.5	19.4	12.6	13.6	8.5
10~14	51.8	34.5	34.1	22.5	15.3	15.1	10.1
15~19	51.6	35.1	36.5	25.9	18.9	16.8	12.9
20~29	55.2	42.1	43.8	34.5	27.7	25.5	22.4
30~39	73.3	64.7	62.3	54.0	48.2	50.2	45.6
40~49	96.0	87.8	85.5	78.0	72.6	73.3	68.1
50~59	100.0	100.0	100.0	100.0	100.0	100.0	100.0
60~	95.1	98.3	104.0	107.0	116.2	121.1	130.5
per capita supply	131.7	156.4	154.5	149.7	143.4	145.6	(kg/year) 142.5

Sources:DerivedincurrentwonfromKrHouseholdExpenditureSurveys,bytheauthorbymeansoftheTMImodel. KREI, Food Balance Sheet, various issues [31], for per capita supply.

5. Conclusion

When/ where one eats more, one will get bigger in stature but not taller in height, after the age of 20. If one eats more animal products,onewillmostlikelygrowtallerinheight,unlesstotalcalories and other essential nutrients are insufficient in supply. Childrenin Japan ceased to grow taller in height in the end of the 1980s, despitecontinuedincreasesinanimalproducts,astheauthorcontends, because they have drastically reduced fruit consumption, sincetheendofthe1970s.Onlyayearago,theauthordiscovered from the government publication of *Household Expenditure Sur- veys*, Statistics Korea that children in South Korea started in the beginning of the 1990s, very likely a little earlier, to turn away from vegetables in at-home consumption. They consumed only 15% of vegetables consumed by the middle-aged adults in their 50sin2010,andfurtherdowntothe10%thelevelintheendofthe 2010s.Thistendencycouldbecalled“wakamononoyasai(=Kimchi)-banare” in South Korea, equivalent to “wakamono no kudamono-banare” since the end of the 1970s in Japan, both of which are common in nature that the newer generations are structurally negative in cohort effect for vegetables and/or fruit consumption [34-36].

References

1. Richard HS. Stature and the standard of living. J Economic Literature.1995; 33: 1903-40.
2. Angus D. Height, Health, and Development. PNAS. 2007; 104: 13232-7.
3. Cole TJ. The secular trend in human physical height: a biological view. Economics and Human Biology. 2003; 1: 161-8.
4. PrenticeAM,WardKA,GoldbergGR,JarjouLM,MooreSE,etal. Criticalwindowsfornutritionalinterventionsagainststunting.AmJ Clin Nutr. 2013; 97: 911-8.
5. ColeT,MoriH.FiftyyearsofchildheightandweightinJapanand SouthKorea:Contrastingseculartrendpatternsanalyzedby SITAR. Am J Human Biology. 2018; 23054.
6. Matthias B. Cultural and genetic influences on the ‘biological standard of living’. Historical Method. 2013; 46: 19-30.
7. MoriH.SeculartrendsinhumanheightinSoutheastAsiancountries afterWWII.OpenJNutritionandFoodSciences.2022;4:022-026.
8. Chosun I, Chosun Nippo C. Japanese edition on line. 2016.
9. KopczynskiM.Bodyheightasameasureofstandardofliving:Europe,America andAsia. Roczniki Dziiejow Spolecznychi I Gospodarczych Tom. 2016; 76: 39-60.
10. Japanese government, Ministry of Health, Labor, and Welfare. National Nutrition Surveys, various issues.
11. Ministry of Education, School Health Examination Survey, various issues.
12. Republic of Korea, Korea Centers for Disease Control and Prevention. Korea National Health and Nutritional Examination Survey, various issues.
13. DepartmentofEducation,CenterforEducationalStatistics.Statisti- cal Yearbook of Education, various issues.
14. United Nations, FAOSTAT, Food Balance Sheets, 1961~2013, old methodologies.
15. Japanesegovernment,MinistryofAgriculture,ForestryandFisher- ies (1995). White Paper on Agriculture 1994, Tokyo.
16. Japanese government, Bureau of Statistics, Family Income and Expenditure Survey, various issues.
17. IbaY. Chairman, Symposium on Declining Fruit Consumption and Age Factors, Chapter 3, Cohort Analysis of Japanese Food Consumption-NewandOldGeneration,editedbyHiroshiMori,Senshu University Press, 2001.
18. MoriH,ClasonD,IshibashiK,GormanWD,DyckJ.Decliningorangeconsumptioninjapan:generationalchangesorsomethingelse? ER Report #71, USDA. 2009.
19. Japan Federation of Soft-Drink ManufacturersAssociation.Annual Report of Soft Drinks, various issues, Tokyo.
20. Mori H, Inaba T. Estimating individual fresh fruit consumption by age, 1979 to 1994, Journal of Rural Economics. 1997; 69: 175-85.

21. Tanaka M, Mori H, Inaba T. Re-estimating per capita individual consumption by age from household data. Japanese J Rural Economics. 2004; 6: 20-30.
22. MoriH.StructuralchangesinfoodconsumptionandhumanheightinEastAsia,LAMBERTAcademicPublishing.Berlin.2020;1-156.
23. Sugiura M, Nakamura M, Ogawa K, Ikoma Y, Ando F, Yano M,et al. Bone mineral density in post-menopausal female subjects is associated with serum antioxidant carotenoids. Osteoporosis International. 2008; 19: 211-9.
24. SugiuraM,NakamuraM,OgawaK,IkomaY,YanoM.HighSerumCarotenoidsAssociatedwithLowerRiskforBoneLossandOsteoporosisinPost-MenopausalJapaneseFemaleSubjects:Prospective Cohort Study. PLOS ONE. 2012; 7: 1-9.
25. SugiuraM,NakamuraM,OgawaK,IkomaY,YanoM.Highserum carotenoids associated with lower risk for the metabolic syndrome and its components among Japanese subjects: Mikkabi prospective cohort study. British Journal of Nutrition. 2015; 114: 1674-82.
26. Nakamura M, Sugiura M. Serum β-carotene derived from Satsuma mandarinandbrachial-anklepulsewavevelocity:TheMikkabicohortstudy.Nutrition,Metabolism&CardiovascularDiseases.2016; 26: 808-14.
27. McGartland CP, Robson PJ. Fruit and vegetable consumption and bonemineraldensity:NorthernIrelandYoungHeartsProject.AmJ Clin Nutr. 2004; 80: 1019-23.
28. Vatanparast H, Jones AB, Faulkner RA, Bailey DA, Whiting SJ. Positive effect of vegetable and fruit consumption and calcium intakeonbonemineralaccrualinboysduringgrowthfromchildhood to adolescence: The University of Saskatchewan Pediatric Bone Mineral Accrual Study. Am J Clin Nutr. 2005; 82: 700-6.
29. Prynne CJ, Mishra GD. Fruit and vegetable intakes and bone mineralstatues:Acrosssectionalstudyin5ageandsexcohorts.Am.J. Clin. Nutr. 2006; 83: 1420-1428.
30. LiJJ,HuangZW.FruitandvegetableintakeandbonemassinChineseadolescents,youngandpostmenopausalwomen.PublicHealth Nutrition. 2012; 16: 78-86.
31. Sanghyo K. Research Fellow, Korea Rural Economic Institute, Courtesy. 2021.
32. RepublicofKorea,StatisticsKorea,HouseholdIncomeandExpenditure Survey, 1990 to 2019.
33. MoriH.Criticalperiodsduringchildhoodandadolescence:astudy ofadultheightamongimmigrantsiblings.2011[1]InternationalJof Clinical S & Medical Case Reports. 2021.
34. Mori H, Stewart H. Cohort analysis: ability to predict future consumption-ThecasesoffreshfruitandriceinKorea.AnnualBulletin of Social Sciences, No. 45, Senshu University. 2011; 153-73.
35. Mori H, Cole T, Kim S. Boys' height in South Korea in the past threedecades:Whytheyceasedtogrowtaller?-Steeringawayfrom Kimchi, Senshu Economic Bulletin. 2021; 55: 29-39.
36. Mori H. Dutch, the world tallest, are shrinking in height: lessons from the cases of Japan and South Korea. Food and Nutrition Sciences. 2022; 13: 85-96.