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Research Article

Secular Trends in Human Height in Southeast Asian Countries after WWII

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Abstract

Most countries in Southeast Asia achieved substantial economic progress after the end of WWII. Accordingly, people increased in height steadily, some countries very fast, like Taiwan and others substantially slower in growth, like Indonesia. Food consumption improved in quantity and quality, with supply of animal products expanded appreciably in most countries. Statistically, animal protein has proved distinctly positive in height increase in cases like Taiwan, while not appreciably effective as in Vietnam in the latest few decades. Much remains to be done, in regards to data collection, particularly trends in food consumption by children in growing ages, in order to shed more light on the changing heights of children in Southeast Asia.

Keywords: Height; Southeast asia; Young men; Animal products; Healthy diets

Introduction

Most countries in Southeast Asia became independent from colonization by the western nations after the end of WWII and started to pursue their own development paths, with some successfully fast like Malaysia and Singapore and others inadequately like Vietnam and Laos. Generally assisted by "Green Revolution", agricultural production made fantastic progress and food supply improved remarkably. Accordingly, people grew appreciably in stature [1,2].

The author came across, by chance, one of few empirical studies of human height development in Indonesia in the past half century. With his scant experience with children's height growth in Japan, in comparison with South Korea, mainly from food consumption perspectives in the past half century, he compared secular trends in men's height and per capita food supply in selected countries in Southeast Asia in the past half century. The main purpose of this note is to invite those who are acquainted with the economies of Southeast Asia to join the empirical investigations of human height growth in the framework of economic developments.

When the author found on the internet, the paper title, "Secular trends in Javanese adult height: the roles of environment and educational attainment", Annang G. Moelyo, BMC Public Health [3], he misread Javanese as Japanese.

Secular trends in men's height in the past half century in Southeast Asia

Table 1 is an excerpt of Table 1 Javanese adult height among "total" and large cities, A. G. Moelyo, p. 3, which provides changes in male adult height by 20 to 40 years of age from 1955 to 1995, in Indonesia's island of Java. In consideration of the biological fact that men do not grow any taller after the age of 20 and do not shrink in height before the age of 40, Table 1, Moelyo, should be commended for its realistic approach for supplementing insufficient observations of human stature by age in a long run basis, nearly a half century. Men in their early twenties in Java grew in mean height from 161.2 cm in the mid-1970s to 165.8 cm in the mid-2010s in "total" and from 162.9 cm to 166.6 cm in large cities.

The author obtained, by luck, consistent data on mean height of men at age 18 by birth year from 1930 to1996 in selected countries in Southeast Asia, by 5 year-interval from Our World in Data, Max Roser, and Oxford [4]. Figure 1 shows trends in mean height of men at age 18, by birth year, 1930, 1940, 1950, 1960, 1970, 1980, 1990, and 1996 in Indonesia, Malaysia, Thailand, Vietnam, and Taiwan, all of which, except for Thailand, were under colonial rule by some of advanced nations before the end of WWII, 1945.

Those born in 1930 aged to 18 years old in 1948, shortly after the end of the war and those born in 1990 aged to 18 years old in 2008, and then likewise those born in 1996 were 18years old in 2014. One thing distinctly common in the five selected former colony nations manifests that young male adult increased steadily in mean height during the half century after the end of the war, with some differences in absolute mean height and in growth patterns. Taiwan was the highest at the outset, 1948(birth year=1930), followed by Malaysia, with 3 cm handicap at 162 cm, and Indonesia was the shortest at 158 cm in mean height.

Table 1: Average height of male adults by birth year in Java, Indonesia.

	Total		Large cities	
	n	avg height	n	avg height
1955	267	161.2	63	162.9
1960	1123	161.4	246	162.5
1965	1540	162.4	374	163.3
1970	2257	162.6	523	163.4
1975	2801	163.0	709	164.3
1980	2771	164.0	650	165.2
1985	1800	164.7	426	165.3
1990	881	164.9	199	165.9
1995	389	165.8	96	166.6

Sources: [3] Javanese adult height, p.3.

Notes: each birth year represents 5 years, e.g., 1955 ranges from July 1952 to June 1957.

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What looks striking is that Taiwan was the highest in absolute mean height from the beginning and consistently the fastest in growth, slightly exceeding 174 cm in 2014(=1996 birth cohort). Malaysia kept the second position in mean height until the 1980 birth cohort (18 years of age in 1998), overtaken by Thailand by nearly 2 cm in 2014 (Figure 1).

Indonesia kept growing all the way from the end of the war to the mid-2010s but began to slow down after the mid-1980s (1965 birth cohort) to be 163.6 cm, the shortest of the five nations, selected in Figure 1, at the end of the survey period, 2014 (birth year,1996). The audience should recall that Table 1 from AG, Moelyo, represents Java-island, where the nation's capital, Jakarta is located.

Discussions in General

It is widely conceived that people in the northern part of the world, or even within the same land of the nation, should be taller in mean height than those in the southern parts [5,6]. In Europe, where Caucasians predominate, populations in Sweden and Netherlands, for example, are observed appreciably taller in mean height than those in Italy and Portugal. However, data do not strongly support this conception Figure 2 [4] demonstrate secular trends in mean height of men at age 20, by birth year, 1850 to 1980, in two northern and two southern countries in Europe. The Dutch have been the world tallest since the 1980s, significantly exceeding 180 cm in mean height, overtaking the Portuguese, in the southern region of Europe, by 10 cm in mean height. Over a century ago, the Dutch were nearly the same as the Portuguese at 165 cm in mean height at age 20 in 1870 and some 3 cm shorter than Norwegians in the northern Europe in the latter half of the 19th century. The Dutch started to grow significantly faster in 1950 (1930 birth cohorts) than the Norwegians to overtake the latter by nearly 3 cm in 1980 (1960 birth cohort). Coincidentally, the Spaniards started to grow very fast in height in 1960 (1940 birth cohorts) to overtake the Portuguese by 5 cm in 1980, whereas the latter has kept growing steadily but the more slowly since the beginning of the 20th century. Figure 2 demonstrates decisively that neither ethnicity nor geographical location should be the key determinant of the human height.

In human biology, numerous empirical investigations have been undertaken to explain the development of human height in Europe, in particular [7], how have Europeans grown so tall], [[8], why are you tall, while others are short], [9], many more). Increases in food supply (=consumption), animal protein in particular, have been ascertained to be positive correlates of growth in human height.

Blum [10] supplemented the animal-protein theorem by stating that "the central determinant of human stature is the protein-intensity of a nation's diet. Populations consuming larger amounts of animal protein reach higher average height levels than countries with less animal protein consumption. However, a high consumption of animal protein alone does not result in increasing body heights if the overall consumption of calories and other essential nutrients is insufficient", p. 21, without specifying what "the other essential nutrients" could be.

Mori speculated that fruit and/or vegetables could be essential in augmenting children's growth in height, by empirically analyzing children's height growth in Japan and South Korea during the recent few decades. Children in growing ages, not the entire population, drastically turned away from fruit in Japan and those in South Korea started to reduce vegetable consumption drastically in the beginning of the 1990s, resulting in plateauing of height, when animal protein was still increasing in both countries [11-14].

FAOSTAT, United Nations, started to publish per capita consumption of various food products, in terms of per capita kg/year and/or kcal/day, for UN member countries, in1961 in Food Balance Sheets, old methodologies from 1961 to 2013[15] and new methodologies from 2000 to 2019 [16]. All the data are for the entire individual nation, either total population or simple per capita, by year or day, not classified by age groups of the population. Hence, if per capita consumption of milk, for example, is high in any country, children in growing ages could be substantially lower or even higher than the country average, in the presence of age and cohort effects [17,18,19] One may be safe in assuming though that children, or newer cohorts should be increasing consumption more than the simple per capita average, when total supply of any chosen product has been increasing and vice versa.

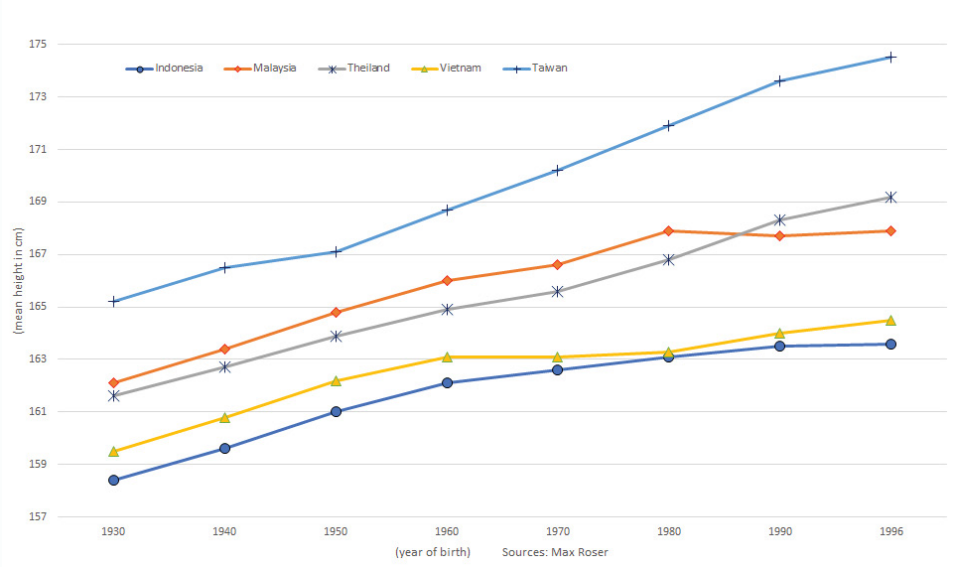

Figure 1: Secular changes in mean height of men at age 18, Indonesia, Malaysia, Thailand, Vietnam and Taiwan, birth year from 1930 to 1996.

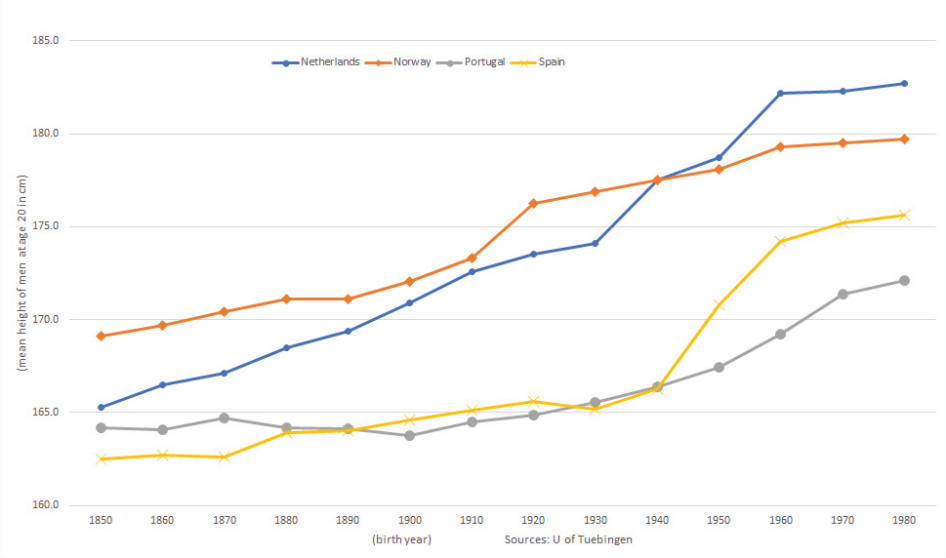

Figure 2: Secular trends in mean height of men at age 20 in selected European countries, birth year 1850 to 1980.

Japan's per capita consumption of fruit was approximately 50 kg/year, about one half the amount, compared to European countries in the latest decades, 1990 to 2010 [15].

Tanaka and Mori estimated that per capita at home consumption of fruit by children, aged 5 to 15, was less than 5 kg/year, nearly one tenth the level, as compared to middle-aged adults in 1995-2005 [[20], Chapters 3].

The author has no access to the age-classified data sources for food supply in countries in Southeast Asia (Table 2). It is assumed implicitly in this note that "all generations should follow the same transformation of eating habits over the life cycle" [21], implying that children should follow the general trends in food consumption changes as total population of the country. When the society is changing rapidly like Japan and South Korea in the past half century, this assumption may not hold true [19], When we discuss increasing trends in human height, we very often come across changes in consumption of animal products: bovine meat, pig meat, poultry meat, eggs, milk, freshwater fish, etc. which are covered by FAOSTAT, Food Balance Sheets, by country. At this moment, we have no alternatives other than depending on FAOSTAT.

Regressions: secular trends in men's height and changes in food supply in Southeast Asia

Figure 3 provides secular changes in men's average height at age 18 by 5-year intervals from 1963, 1968, ----, 2008 and to 2013 [4], average height of men at age 18, by birth year. One born in 1945 aged to 1 year old in 1946 and 18 years old in 1963. In determining adults' height, we often come across (importance of) "early years of life" [22]. Cole and Mori concluded, "most of the height increment seen in adults had already accrued by age 1.5 years", in analyzing secular trend in height during the post-war years in Japan and South Korea [23].

Mori, however, reserved the importance of nutrition "throughout childhood" [24]. Any improvements in nutrition after the age of 20, or even 18 will barely increase men's height. What we have in hand is average height of men at 18 in selected countries over the past half century. For the sake of practical simplicity, it is tentatively assumed that food consumption taken at ages, 12 to 14 years of age is related to the final adult height at age 18: average height observed in 1975, for example, is significantly related to food consumption, during the period of 1969-1971.

In the statistical exercises to follow, average height at year, t, is regressed against per capita average food consumption, grand total caloric intake, caloric supply from animal products, etc., years t-6 ~ t-4, 3-year moving averages by country. In the cases of all five selected countries, average height has proved positively correlated to caloric supply from grand total foods and animal products. When average height is regressed against caloric supply from animal products alone, by country, adjusted R^2 has turned out quite high, substantially higher than when regressed to both grand total and animal products. In most cases, t-values for animal products coefficient have proved also much greater. Mori has often emphasized that fruit and vegetables should be 'essential' nutrients to substantiate animal protein in augmenting children's height growth [11-13]. We will also briefly examine the role of fruit/vegetables for adult height growth in the following paragraph.

Indonesia:

H_{ind}=154.72+0.003Cal-total+0.001Cal-anim adj.R^2=0.89 In-(1)

(93.3) (3.29) (0.13)

H_{ind}=160.10+0.023Cal-anim adj.R^2=0.77 In-(2)

(386.7) (5.94)

H_{ind}=154.54+0.003Cal-totl adj.R^2=0.90 In-(3)

(190.5) (9.75)

Malaysia:

H_{mal}=157.60+0.002Cal-total+0.008Cal-anim adj.R^2=0.95Ml-(1)

(45.1) (1.25) (3.54)

H_{mal}=161.93+0.011Cal-anim adj. R^2=0.94 Ml-(2)

(437.0) (12.84)

Thailand:

H_{tha}=155.80+0.002Cal-total+0.019Cal-anim adj. R^2=0.90 Th-(1)

(61.9) (1.46) (2.79)

H_{tha}=159.30+0.027Cal-anim adj. R^2=0.88 Th-(2)

(205.2) (8.83)

Vietnam:

H_{vet}=157.67+0.003Cal-total-0.0002Cal-anim adj.R^2=0.53Vt-(1)

(25.5) (0.72) (-0.03)

H_{vet}=162.14+0.004Cal-anim adj.R^2=0.55Vt-(2)

(516.8) (3.66)

Taiwan:

H_{twn}=159.51+0.002Cal-total+0.011Cal-anim adj.R^2=0.79 Tw-(1)

(13.4) (0.34) (1.71)

H_{twn}=163.58+0.013Cal-anim adj.R^2=0.81 Tw-(2)

(151.0) (6.61)

A few supplementary trials: supply of vegetables and fruit as additional explanatory variable:

When per capita supply of vegetables and fruit, kg/year, is added to the equations, the regression improved in some cases, like Th-(3) but turned out intuitively unreasonable in the case of Tw-(3),below.

H_{tha}=157.41+0.023Cal-anim+0.021 Kg (veg+frt) adj. R^2=0.93 Th-(3)

(158.5) (7.32) (2.45)

H_{twn}=162.77+0.0002Cal-total-0.001Cal-anim+0.042 Kg (veg+frt) adj. R^2=0.79 Tw-(3)

(13.3) (0.0030) (-0.077) (1.03)

With no exceptions, per capita supply of animal products has contributed to increases in adult height in selected countries in Southeast Asia in the past half century, to varying degrees by country and time-period, which may require further in-depth analyses, needless to mention.

Where, H stands for average height in cm.

ind, mal, tha, vet, and twn stand for Indonesia, Malaysia, Thailand, Vietnam and Province of Taiwan, China.

Cal-total and Cal-anim stand for per capita daily caloric supply in kcal from grand total foods and animal products, respectively.

Kg (veg+frt) stands for per capita supply of vegetables and fruit in kg/year.

Conclusions, Accompanied with Strong Recommendations

Adult height is a net measure that captures the supply of inputs to health throughout childhood [1], including prenatal periods. In developing countries (not necessarily underdeveloped countries), "inputs to health" during the early years of life could have been far below those prevalent during pubertal spurt. One never grows instantly from birth to young adult hood; say 18 or 20 years of age. To comprehend one's growth patterns in height, the researchers are supposed to be familiar with the changes in "inputs to health" from "early years of life" up to the maturity.

Table 2: Changes in per capita grand food and animal products, selected countries in South East Asia, 1962 to 2019

	Average intakes of grand total food products (kcal/day)				
	Indonesia	Malaysia	Thailand	Viet Nam	Taiwan
1962	1826	2427	2004	1935	2496
1970	1929	2556	2190	1973	2589
1980	2250	2747	2184	1952	2777
1990	2433	2643	2167	1917	2948
2000	2442	2857	2580	2246	3078
2010	2655	2868	2750	2677	2952
2015	2858	2843	2780	2847	2957
2019	2912	2920	2798	2928	2964
Average intakes of animal products (Kcal/day)					
1962	55	255	169	140	233
1970	57	286	201	132	330
1980	74	407	198	113	509
1990	111	487	254	163	651
2000	124	513	299	274	706
2010	170	528	335	555	652
2015	182	546	358	575	658
2019	227	514	369	612	684

Sources: FAO, FAOSTAT Food Balance Sheets, on the internet.

Table 3: Changes in per capita supply of vegetables and fruit, selected countries in South East Asia, 1962 to 2019.

	Average supply of vegetables (kg/year)				
	Indonesia	Malaysia	Thailand	Viet Nam	Taiwan
1962	16.6	21.3	42.6	47.5	60.3
1970	17.7	26.7	50.5	44.2	74.2
1980	16.0	24.2	51.4	41.1	122.1
1990	22.8	25.2	38.0	43.5	109.7
2000	32.5	36.1	51.0	73.7	135.5
2010	40.2	63.2	49.2	82.4	113.0
2015	42.0	72.0	38.0	154.0	114.0
2019	45.0	69.0	39.0	169.0	116.0
Average supply of fruit (kg/year)					
1962	22.4	59.8	66.1	35.8	23.0
1970	26.3	59.6	66.2	34.9	45.5
1980	26.0	56.8	114.5	40.7	65.6
1990	27.1	53.4	87.1	42.0	110.0
2000	36.3	54.1	122.5	49.4	119.9
2010	63.7	45.7	106.8	67.9	115.9
2015	64.0	45.0	84.0	68.0	97.0
2019	68.0	42.0	72.0	72.0	93.0

Sources: FAO, FAOSTA, Food Balance Sheets, on the internet.

To determine growth curves of young male adults at age 20 in 1980, for example, it is imperative to follow "inputs to health" from 1960, the year of birth to 1979, the year of maturity. In the case of male adults at age 20 in 2015, changes in "inputs to health" from 1995 to 2014 need to be taken into consideration, to determine how the growth curve has been shaped. Even when the average height at the maturity stays the same for a decade or two, as observed in South Korea in the current century, since the early 2000s, the growth velocities during the adolescence years have declined appreciably [13,14]. Cole suspects that Korean young adults would decline in mean height toward the end of the 2020s, despite continued increases in consumption of animal protein, probably because the newer birth cohorts have been reducing consumption of vegetables conspicuously [25,26].

Japan is a pioneering country in publishing national nutrition surveys, based on the nationwide large samples in the end of the 1940s. The National Health and Nutrition Survey started to publish intakes of nutrition and food products, classified by the age of individuals only in 1996 [27]. Republic of Korea followed suit in publishing

comprehensive surveys, Korea Health and Nutrition Examination Surveys, in 1998, followed by the 2nd one in 2001 and 3rd one in 2005 [28]. Japanese government Statistics Agency has been conducting Family Income Expenditure Surveys since the early 1950s and started to publish household expenditures on major commodities, along with average prices attached, classified by the age groups of Household Head (HH) in the 1970s [29]. Mori and Inaba (1997) designed econometric models to derive per capita at-home consumption of fresh fruit by age groups of household members from FIES, classified by HH age groups [30]. Republic of Korea, Statistics Korea, publishes Household Income and Expenditure Surveys, classified by the HH age groups, attached with household age structures, which makes the estimation of consumption of individual household members by age practically easier [31]. The author has been contending that "steering away from fruits" by children since the mid-1970s in Japan should have something to do with the plateauing of children's height in the past three decades and turning away from Kimchi by children since the early 1990s may have caused the stagnation of children's height since the mid-2000s in South Korea [32].

What cause changes in average height of young adults at age of 18 or 20 is changes in inputs to health throughout child hood from "early years of life" through the late adolescence, not the total population from the infants to the elder at any given year or years. The young adults in Vietnam were 164.5 cm in average height in the mid-2010s, nearly 5 cm shorter than those in Thailand (Figure 1). In respect of per capita caloric supply from animal products, Vietnam was 555 kcal/day in 2010, more than 200 kcal greater than in Thailand, 358 kcal in the same year. With respect to per capita supply of vegetables, Vietnam was 82.4 kg/year, more than 30 kg greater than in Thailand in 2010. But 20 years back in 1990, Vietnam was 163 kcal/day, 100 kcal smaller than Thailand, in respect of caloric supply from animal products. The author speculates that young adults in Vietnam would grow faster in height than in the past decades and would be as tall as those in Thailand toward the end of the 2020s but is not certain at all. The audience is advised to look at Figure 2, which depicts what have occurred in four counties in Europe in the past one and half centuries, in respect of average height of young men, conscripts.

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