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## *Commentary. Human growth, height, size* **Reasons to be small**



Thomas Samaras

Reventropy Associates

San Diego, California, USA

Email: [samarastt@aol.com](mailto:samarastt@aol.com)

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## Introduction



Almost everybody these days thinks that it is best to be tall, meaning much taller than the average traditional height of Asian populations, and even taller than the current average height of populations in high-income countries. It is also often believed – though people might be shy to admit this – that tall people are intrinsically superior to short people. The expressions ‘look up to’ and ‘look down on’ are significant.

I take a different view. All relevant things considered, I am sure that it would be better if the human species was shorter and smaller than is now the case in most countries. Over 35 years of study and thought have confirmed me in this judgement. Indeed, I will go further and say that given dwindling non-renewable resources, yet a rapidly increasing global population, a smaller human race is essential for the welfare and perhaps even the continued survival of our species.

In this commentary I will sometimes refer to specific people. I do this partly because of the obnoxious prejudice against small people, a phenomenon mostly of the last half-century or so, reinforced by what I see as short-sighted views of nutrition scientists. The result has been to overlook and even degrade the eminence and achievements of people who happen to be relatively short. Thus to introduce and illustrate my thesis, here above is a picture of a meeting hosted by Margaret Chan, the current Director-General of the World Health Organization. The man next but

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one to Dr Chan to the left is Kul Gautam, recently retired as deputy executive director of UNICEF, and a leading contender to chair the UN Summit on non-communicable diseases to be held in New York this September. As can be seen by comparison with former UK prime minister Gordon Brown, whose height is 1.80 metres (5 foot 11), and who standing next to Dr Chan to the right, her height is about 1.54 metres (5 foot 0.5) and Kul Gautam's height is about 1.50 metres (4 foot 11). Margaret Chan is taller than was the British Queen-Emperor Victoria, and is perhaps about the same height as the current Queen Elizabeth now is. Kul Gautam is a bit shorter than the German philosopher Immanuel Kant, and a lot taller than the Mexican statesman Benito Juarez.

There is a special reason to note that Margaret Chan and Kul Gautam are decidedly short, measured against the average heights of people native to high-income countries, and even of people from their own countries. They hold, or have held, very high office in the two UN agencies that are specially dedicated to ensuring that children 'fulfil their genetic potential' for height. This dogma is commonly interpreted to mean that short small young children, including those showing no sign of illness, should be fed special energy-dense diets that will accelerate their growth, so that their weight and height 'catches up' to ranges that are deemed in childhood and then as adults, to give them the best chance in life.

But would Margaret Chan and Kul Gaetam have done better, if their 'genetic potential' had been successfully 'fulfilled' so that that they were now taller? Or are they simply very unusual cases of individuals genetically programmed to be short? Or what? In rural areas of their native Asian countries of China and Nepal, they would not be conspicuously short, as they seem to be in the photograph.

So I start this commentary with questions addressed to public health and nutrition professionals, and also to all of us who are concerned with human welfare. Why do practically all of us believe that it is better that individuals, and populations, are comparatively tall, and very tall relative to the traditional heights of many Asian populations? What is the basis of this view? Why do we seem to be so sure of it? Isn't it possible that traditional Asian heights represent a better adaptation? Isn't this obviously so, if we take economic and environmental as well as biological factors into account, in a world increasingly short of fuel and food? Isn't it possible that higher-income and urban populations throughout the world are too tall, and that almost all readers of this commentary are unnecessarily tall, and not a model for future generations? These are challenging questions, which I believe that the public health and nutrition professions, and all relevant policy-makers, need to face, now.

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*Box 1*

## **A personal journey**

Here is some information about me and my work. What's here below elaborates some of the information in my Association [member's profile](#), on-line this month. I am not a medical doctor, nor a qualified nutrition scientist. However, my training and profession is relevant to public health. I graduated in engineering in 1959 and worked for many years in the aerospace industry, mostly in the area of configuration management. This is a sub-discipline of systems engineering that emphasizes evaluation of relevant factors on the success of a physical system. Later in my career, and after retirement from engineering, I have applied this approach to the human system by evaluating how body height and associated weight affect physical performance, chronic disease, longevity, intelligence, and our environment. I also have looked at the fiscal costs of increased body size.

Since childhood I have been interested in health and longevity, and about why we age. The discipline of thermodynamics provided an answer for me. From the sub-discipline of thermal physics, I found that the tendency towards disorder (entropy) of a physical system is related to its mass and energy content. I thought that this simple law could be applied to human systems. My thesis that mass and energy promote entropy, which in turn promotes human ageing, was first published in 1974 (1). While the entropy concept was around before I formulated my thesis, I believe that my mass-energy combination in relation to humans was original.

I was aware that studies involving calorie restriction had for many years shown that this was an effective method for avoiding chronic diseases and extending the longevity of animals. Animal studies find that calorie restriction reduces chronic diseases and extends longevity. This may well also be true in humans (2,3).

I decided to see whether body mass also reduced longevity in humans, using height as an index of body mass, and I looked for registers of populations of people whose height had been reliably measured. A survey of over 750 successful people including US presidents, boxers, baseball players, and other celebrities, showed a substantial decline in longevity with increasing height. These findings were published in 1978 (4). I subsequently used the *Baseball Encyclopedia* to examine the height-longevity relation for about 3100 deceased players. The results were similar, as were those of later studies (5).

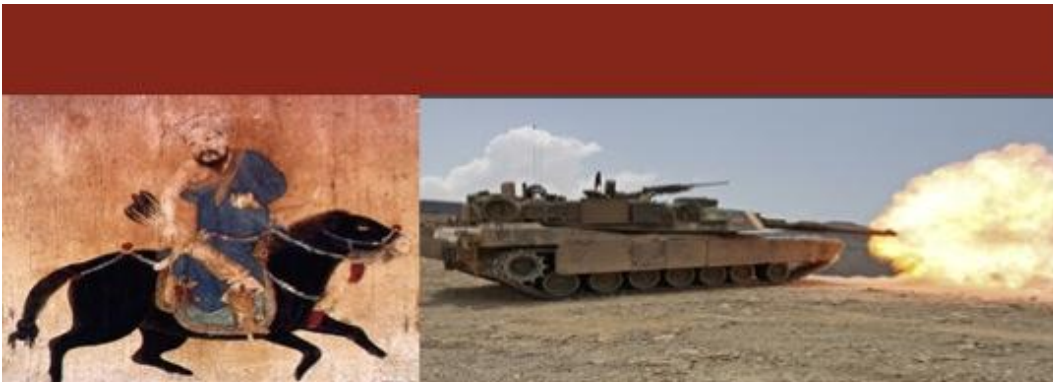
Around 1990 I was introduced to Lowell Storms of the Medical School of the University of California at San Diego. He suggested that we look at the longevity data of US veterans. The data was made available by the Veterans Administration

Medical Center in San Diego. We found that shorter veterans lived longer. Our findings were published in the *Bulletin of the World Health Organization* in 1992 (6).

A few years later I met Harold Elrick, a physician who spent his life studying nutrition, exercise and longevity. Storms, Elrick and I agreed to work together. In 1993 I established Reventropy Associates to focus full-time on the implications of increasing body height as well as weight on human health, longevity, resource needs and other aspects of body size. We published a number of papers in medical and scientific journals. By now I had evaluated over 5000 peer-reviewed papers, and hundreds of books and reports, concerned with height and body size and its relation to physical performance, intelligence, growth, chronic diseases, nutrition and longevity. Much of this work is summarised in the book of which I am chief editor, published in 2007 (7-9). Recently I have published other papers (10-14).


And the answer to the question you were too polite to ask? As a boy I did not have sand kicked in my face. As a US citizen I am of average height.

## The 'big is best' paradigm



Invader of Baghdad (1)	Invader of Baghdad (2)
Height (man) 1.60 m (5 ft 3) *	Height (man) 1.78 m (5 ft 10)
Weight (man) 65 kg (144 lb)	Weight (man) 85 kg (187 lb)
Weight (pony) 160 kg (350 lb)	Weight (tank) 60,000 kg (130,000 lb)
Fuel (man) forage; (pony) grass	Fuel: (man) burgers, coke; (tank) petrol mpg 1
Biogradable: both yes	Biogradable: man yes, tank no

\* Matthew Paris, 1240



This commentary explores the impact of body size, independent of body mass, on physical performance, intelligence, resource consumption, environmental damage, chronic disease and longevity. My findings are based on the laws of physics, and a review of over 5000 scientific and medical papers, books, and reports. My findings do not agree with the existing paradigm that rapid growth and taller bodies are best. Indeed, I think that a physically big world population is not consistent with long-term human survival. In any one paper, it is possible only to give a broad view with a few examples and a small number of references. More details and many more references are in my book on this topic (7).

Throughout history, within any society, the better off and ruling classes have on average, been taller than the working or peasant classes. As a result, we associate taller height with privilege, higher status and power. Today, probably everywhere in the world, taller people tend to earn more, and are more likely to hold higher positions in their fields. In addition, populations in materially rich countries are taller than populations in lower-income countries, due to abundant food including that which promotes growth, good medical care, and healthful environments. Taller height is almost universally viewed as a desirable physical feature, and promotion of increased height and body weight has been an axiom for nutrition scientists (15).

The belief that it is best to be tall, is linked with a general way of thinking, that it is best to grow fast and to be big. This is not just a matter of human size. Lower-income countries are termed ‘developing’. Politicians are driven by economists who advocate more growth, meaning more production and consumption. When countries do not ‘grow’ or ‘develop’, the media are full of stories of gloom and doom. The environmental impact of this way of thinking is already disastrous.

It is not true that massive amounts of energy are needed for success. Sometimes the reverse is the case. The provocative illustration that introduces this section is from a presentation on the topic of human height and weight, made at the Second World Congress on Public Health Nutrition in Porto last September (16). It shows the ways in which Baghdad has been invaded. Mongol horseman conquered what is now Iraq in the 13th century. They were shorter than the armies they defeated, they were lightly armoured, and they created the biggest contiguous empire ever. They massacred the taller heavily armoured European knights mounted on big horses. The most recent invasion has been by the US and allied armies (and I cannot resist pointing out that tank crews, like any workers in confined spaces, are usually relatively short men). The contrast in the use of energy is impressive. These broader considerations, while relevant, are beyond the scope of this brief commentary.

## **The world is becoming tall**

Unfortunately, our rapture with greater height has clouded our judgement. In earlier times, a larger body size usually provided protection from predators or enemy armies – although not always, as the Mongol example shows. But does greater body height enhance human development and survival in today's world? And what role has the nutritional practice of promoting diets containing large amounts of animal protein contained in milk, dairy products and meat, which diets usually also contain large amounts of energy-dense processed foods, on our current height, weight, health, resource needs and environment?

As a systems engineering and management specialist, I have studied the ramifications of increasing human size on our physical performance, intelligence, resource consumption, the environment, chronic diseases and longevity. During my research, I was surprised to find that environmentalists focus on the problems of increasing numbers of people in the world, but ignored their average size. Thus, they miss one half of the equation related to environmental sustainability and the carrying capacity of the earth.

Obviously, a world male population averaging say 1.65 metres (5 foot 5 inches) and 65 kilograms (144 pounds, or 10 stone 4), requires a lot less of virtually every resource, compared with a population averaging 1.80 metres (5 foot 11) and 90 kilograms (198 pounds, or 14 stone 2). These figures are not plucked out of the air. The lower weight figure is that of the United Nations 'reference man' used to calculate human nutritional requirements less than 40 years ago (17). The higher weight figure is that of US males currently. The lower height figure is the average for males in Mexico, Peru, Nigeria, Vietnam and other countries. The higher figure is the current average for white US males.

The same points apply to women, who on average are around 10-13 centimetres shorter than men. (I apologise for only citing figures for men. As an aside, and I will return to this below, women generally live 5-7 years longer than men. We all know this, but surprisingly little research has been done on the reasons why).

Increases in average human height are no more a matter of chance than increases in weight. Since the 1920s, US males have on average grown taller by about 6 centimetres (2 ½ inches) and their average weight (including blacks and Latinos) has massively increased from 65 to 85 kilograms. They are sometimes known as human humvees. Europeans have also grown much taller.

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Tallness is correlated with bigness. Not all tall people are big, and not all short people are small. However, an evaluation of over 80 populations that I have made (these data await publication) shows that taller populations have higher average body mass, compared with shorter ones. Thus, in general taller people weigh more and are also fatter than shorter people. This is not surprising. Shorter populations generally are of lower-income countries, whereas taller populations generally are of materially rich countries where there is more than enough to eat, and food is plentifully available.

Height tends to increase with total protein intake, percent of protein intake, and total energy intake (18). Height, size and mass is largely a function of nutrition. So nutrition scientists have a key responsibility to understand the implications of promoting increased height – and associated body weight and mass.

Will current nutritional recommendations eventually produce a world population of men who are over 1.83 metres (6 foot)? Young Dutch males are now over 1.84 metres, and males living in the Dinaric Alps, in former Yugoslavia, are on average now 1.85.5 metres. The Dutch, who were once short, appear still to be growing. Food drives growth. And also, taller populations can be created through the combination of genetic manipulation with plenty of growth-promoting food. The widespread manipulation of an embryo's genes, with the intention of producing even taller adults, is probably less than 20 years away. The environmental and other impacts of any such 'breakthrough' would be massive.

## **Performance and achievement**

In this section I summarise some findings on performance and on intelligence, including achievement. These do not apply to all individuals, due to variations in genetic makeup, training, motivation, and experience.

### **Performance**

Various sports, particularly those devised or promoted in the US, require greater reach or strength. Here, tallness is an advantage or is essential (19). These sports include American football, basketball, swimming and sprinting. This is illustrated below in the left-hand picture, with estimates of the average height, weight, type of fuel (food), and energy turnover of American footballers (16).

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US footballers	Female gymnast
Height 1.88 m (6 ft 2)	Height 1.52 m (5 ft 0)
Weight 114 kg (250 lb)	Weight 40 kg (88 lb)
Fuel: steaks, burgers, Coke™ (maybe coke)	Fuel: anorectic
Energy turnover 5,000 kcal+	Energy turnover 2,000 kcal ?

However, many sports are better played by shorter or smaller athletes. These include gymnastics, figure skating, diving, long-distance running, and car racing. Supreme martial artists are usually short people; Bruce Lee, Jet Li and Jackie Chan are examples. This is illustrated above in the right-hand picture of the Olympic gold medallist Olga Korbut, with her height and weight, and a guess of her type of fuel and energy turnover.

Some sports incorporate different weight categories. Short people can be excellent boxers, wrestlers, and weightlifters. For example, the weightlifter Naim Sulymanoglu, who is 1.50 metres, or 4 foot 11, has won three Olympic gold medals. The boxer Joe Walcott, 'the Barbados Demon', was about 1.55 metres, or 5 foot 1, and never weighed more than 67 kilograms (148 pounds). The world welterweight champion, he defeated many boxers up to the light heavyweight class (19). He coined the phrase 'the bigger they are, the harder they fall'.

Physical advantages of taller persons include fewer steps to cover the same distance, greater lifting or throwing ability, faster swimming, and greater work capacity. Taller people can also jump higher, due to their greater height and center of gravity. Other advantages are their ability to keep warmer in cold weather, due to their relatively lower surface area in proportion to body weight. They also have lower resting

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metabolic and heart rates, generally believed to be healthier. Taller people are also less likely to become dehydrated; they lose less moisture due to their smaller surface area in comparison to body mass.

In contrast with the advantages of taller people, shorter people are stronger on a weight for weight basis. Shorter people can lift their bodies more easily than taller people of the same body proportions. Other advantages include quicker reaction times, faster acceleration, and greater endurance (19).

Shorter people can rotate faster and are more agile than taller people. They have a lower center of gravity and so greater stability. Due to their smaller target area, they are less exposed to enemy fire. Francis Galton estimated that a tall infantryman has a 33 per cent higher risk of being killed in combat. A large study also found that smaller people are at lower risk of injury or death in car accidents (19). Risk increased with increasing weight. Most studies that I have seen indicate that short people have fewer hip fractures and back problems. Of course, small, frail people with poor nutrition can certainly have higher hip fractures compared with healthy, well-fed taller people.

### *Intelligence, achievement*



Intelligence and achievement are essential to human progress and survival. You will already have guessed what the six giants of recent and current history shown in the picture strip above, have in common. From the left, they are the savant and statesman François-Marie Arouet (Voltaire); the philosopher Immanuel Kant; the Queen-Emperor Victoria; Vo Nguyen Giap, the general who defeated the French and the US armies in Vietnam (who is due to celebrate his 100th birthday later this year); the economist and promoter of monetarism Milton Friedman; and the Burmese opposition leader Aung San Sui Kyi (with her mother and English husband). All of them were or are around 1.52 metres, or 5 foot 0, with Voltaire and Aung San being maybe an inch or two taller. Most people may say that their achievement was or is despite their lack of stature. I see no good reason to suppose this.

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It is sometimes supposed that taller people are more intelligent because they have larger brains. In fact, neither taller nor shorter people have a significant advantage in intelligence and creative achievements (20).

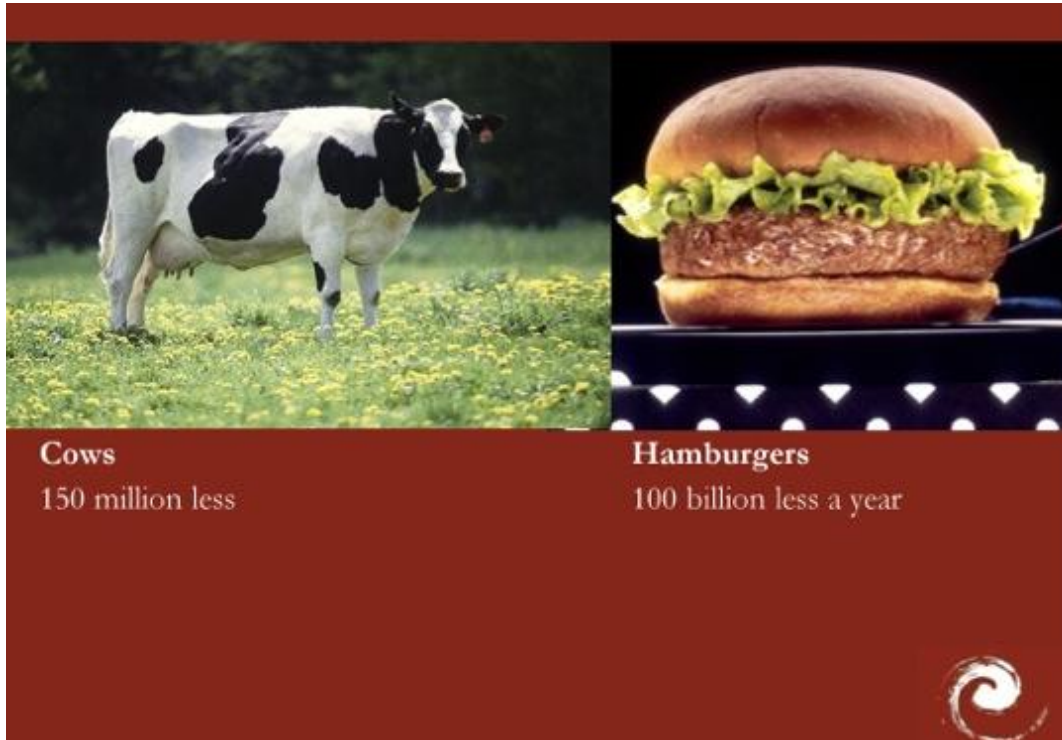
The ancient Egyptians, Greeks and Romans were short by today's standards, as were Europeans in earlier centuries, and were extremely intelligent, creative and productive within the limits of their knowledge base, which was far smaller than that of today. Chinese, Indians and Japanese are shorter than Westerners (until they adopt Western ways of life, including US-style diets), but are just as intelligent and productive. In California, Asians score higher on intelligence tests and achieve higher professional attainment compared with taller Caucasians. This is probably due not to an inherent mental superiority but to a culture that emphasises intellectual achievements.

Great intellectual, political and artistic achievements have been attained by short or relatively short people. As well as Voltaire, Kant, Queen Victoria, Milton Friedman, and Aung San Sui Kyi, these include Michelangelo, Mozart, Beethoven, Keats, Picasso, Miro, Mahler, and Einstein, whose heights ranged from 1.52 metres (5 foot) to 1.67 metres (5 foot 5.5). I have included here just a few examples of accomplished people who happened to be short. A much longer list is available at: [http://www.shortsupport.org/cgi-bin/whowho\\_list.cgi](http://www.shortsupport.org/cgi-bin/whowho_list.cgi)

Animal studies indicating that body height or size does not relate to intelligence include those of the African Grey Parrot, which has a brain the size of a walnut. Researchers at the University of Arizona have shown this animal to be as intelligent as a chimpanzee with its much larger brain. Among the smartest, and also the dumbest dogs, height was roughly evenly distributed among small, average and large dogs. Toy, miniature and standard poodles were rated as having the same intelligence (20).

So, what about women? Women are shorter and have smaller brains than men. However, with the restraints lifted against women in the 20th century, they are clearly in all respects equal with men, apart from when brute force is needed. Indeed, in the US, more women are graduating with advanced degrees than men. This doesn't mean that they are inherently more intelligent; interest in learning and motivation probably account for the difference in gender graduation rates.

## Environmental impact



The environmental case for a smaller human population is surely overwhelming. Yet little attention has so far been paid by researchers on the impact of increasing body size on the world's resources. In 1967, two engineers working at the Massachusetts Institute of Technology pointed out that bigger people need more food and other resources. Following them, in 1978 I analysed the impact of a major further increase in height on resource needs, solely for the US (21). This was the time when environmentalists were becoming increasingly concerned about the impact of increased population and increased production and consumption. In 2002, I developed a new evaluation for the US (22). Perhaps the average height of the US white and black population has almost peaked. But the stature of Asian populations is now rapidly increasing. Almost all nutrition scientists think this is a good thing. I cannot agree.

What would be the environmental effect of a general reduction of 5 per cent in average height (roughly 7.5 centimetres, or 3 inches), a 10 per cent decrease in average weight, and 10 per cent in consumption of energy, compared with actual

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current average figures? These are realistic figures. Average heights of Asian populations are around 12-15 centimetres or 4.5 to 6 inches shorter than those of Western populations. Asian men traditionally have been on average roughly the same height as Western women. The reduction could be achieved in a couple of generations by a transformation of nutrition policies (more on this below), and also now, by policies that slow the growth of Asian children.

An estimate was made in 2010 (16). The results are shown in the pictures above and below. Since the world's cattle population is currently 1.5 billion, a 10 per cent drop in consumption of cows and their products implies a drop in the cattle population of 150 million. Cattle now use up about 27 per cent of our arable land mass. Their combined weight vastly exceeds the weight of all the humans on earth.

Pollution from industrial farming and other human activities has made about half the streams, rivers, and lakes in the USA unfit for fishing or swimming. Given that 20-50 per cent of greenhouse gas is created by animal farming, 10 per cent fewer cows would alone result in a 2-5 per cent reduction in greenhouse gas. Reduction in burger consumption is guessed at 100 billion a year.



The infographic is divided into two columns. The left column, titled 'Oil', features a satellite image of an oil spill in the ocean. The right column, titled 'Water', features a photograph of a large pipe with green algae growing inside it. Below the images, text provides specific savings: 1% less oil (350 million barrels a year) and 8% less water (100 km/cubed a year). Footnotes explain the percentages are based on 10% of current consumption for oil and 10% of agricultural water use for water. A small map of the Gulf of Mexico is in the bottom left of the oil image, and a spiral logo is in the bottom right.

Oil	Water
1% less: 350 million barrels a year * (70 times the Deepwater Horizon spill)	8% less: 100 km/cubed a year **
* 10% of 10% of current consumption	** 10% of 80% used in agriculture

The picture above shows the reduction in human use of oil and of water, solely as a consequence of a 10 per cent reduction in animal production (16). Estimates for all the consequences of a human population with energy turnover 10 per cent lower than now would of course be far higher. Also, big people cost more. As just one example of very many that can be given, a recent study showed that a 4.5 kilogram (10 pounds) increase in the average weight of people in the US would increase airline fuel consumption by 350 million gallons a year (23). This simply tracks the current trend. If we assume a fuel cost of \$US 3 a gallon, the annual additional cost is over a billion dollars.

## Lifespan

You may think that even if future generations will be better off short, we are better off tall. It is generally accepted that being relatively tall increases lifespan and is protective against chronic diseases. This is not my view.

It is true that tallness is associated with longer life in high-income settings, and also is associated with lower rates of cardiovascular disease. But this does not mean that tallness *in itself* is protective. Also, as briefly summarised below, these findings do not apply in other settings. Further, cardiovascular disease is not the only chronic disease. So as a general statement, I dispute what currently is generally accepted. It is not what the evidence shows, at least not the very extensive evidence that I have examined. Judgements here, as in any matter that involves judgement, depend on what type of evidence is seen as relevant and of this what is seen as most impressive.

One problem with examination of the evidence is the need to separate information on height from information on weight and body mass. A vast amount of research has investigated relative fatness, because of the evidence that above certain levels, serious overweight increases the risk of a number of serious chronic diseases. Comparatively very little research has examined height separated from weight and mass, no doubt because almost all researchers currently assume that height is not an issue. Also of course adult height is unchangeable, so investigators have thought that there is no point in looking at it. This is short-sighted: the height as well as the mass of future generations is not immutable. It is therefore necessary to look at 'ecological' data, the first line of evidence in any investigation. Significant findings on height should affect policies for babies and young children, and for the generations not yet born.

As in other aspects of investigation into human height, the question of height and lifespan is vexed. One problem is that in societies where being tall is valued, and where tallness is thought to be in itself healthy, children who grow up to be tall tend to be those with caring parents, to be of higher social class, and to be given better medical and other care. These factors, I think, rather than tallness *in itself*, is what leads to longer life.

In lower income countries, shortness in early childhood is strongly associated with disability, but the issue here, in my view, is pathogenic factors that make children small, notably infection and infestation, and/or poor parental and health care, and general impoverishment including food insecurity and inadequate sanitation. Without these factors I do not think that shortness is an issue. Indeed, my view, based on the evidence that most impresses me, is that shorter height *in itself* increases the chances of longer lives.

Some of my own findings of populations within the USA are mentioned above in Box 1. These have been of classes of people in the US where reliable records existed. My earliest survey showed that shorter US baseball players lived longer. I also found that among famous and powerful people in the US, including former presidents, those who were shorter lived longer. This finding was repeated for US army veterans. Subsequently, I expanded the baseball player study to include over 3100 deceased athletes (7,24).

A study not by me and my associates has found that deceased Ohio male and female residents survived longer if they were shorter. The study, based on 1671 deaths, found males and females lost 0.49 years for every centimetre increase in height (25).

Another study is of 1.3 million Spanish males born around the middle of the 19th century, tracked over a 70-year period. There was a progressive increase in survival for shorter men (26). A further study found the same trend with about 300 Sardinian males tracked over a 70-year period (27). The reliability of the studies comes from heights being measured at the time of military service.

US government data on national mortality between 1985-1999, by different ethnic groups and involving over 10 million deaths (28), shows that Whites and Blacks have an age-adjusted mortality almost twice that of Asians, who are shorter. Native Americans and Latinos are shorter than Whites and Blacks but taller than Asians, and their mortality rates were in between the tallest and shortest groups.

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In the US, men are on average around 7 per cent taller than women and have a 7 to 9 per cent lower life expectancy. The loss of life with increasing height is 0.5 per year for every additional centimetre. It may be considered improper to compare men with women in this way. I disagree. The finding is much the same as when taller males are compared with shorter males (10). Animal research shows that small male rats live longer than larger female siblings.

Outside the US, a study of elderly Swedes has found that shorter men and women have lower mortality than taller people. Men and women lost 0.52 years for every centimetre increase in height (29). An average loss of 0.5 years per centimetre has been found in 10 studies (10,11).

Surveys between populations show that the people in countries and territories that have the longest life expectancy in the world are all relatively short. These are the people of Andorra, Macao, Japan, San Marino, Singapore and Hong Kong. In contrast, the six tallest populations in Western Europe had a lower life expectancy. These include Sweden, Norway, the Netherlands, Germany, Denmark and Finland (10,11).

### **Centenarians**

Most centenarians tend to be short or small (12, 30,31). It has been observed that if you want to live to be 100 it is best to be short and lean and to restrict your protein intake (31). Okinawan male centenarians average 1.48 metres (4 foot 10). If adjusted for shrinkage with ageing their youthful heights were probably about 1.52 metres (5 foot). A recent Cuban centenarian study found youthful male height averaged about 1.55 metres (5 foot 1) (12). Similar findings have been found for Poland, Hungary and Sardinia.

## **Chronic diseases**

The ideology that fast growth equals health is troublesome in very many ways, including many outside of the scope of this commentary or of my work.

## **Accelerated growth**

One very important example is central to my work and that of nutritionists. This is the view that the growth of babies and young children who are small and short, should be pushed, by giving them additional food.

This practice apparently made sense at the time when the main nutritional problem in industrialised countries was undernutrition and nutritional deficiency. And of course children in impoverished settings who are unwell because of inadequate food, need to be nourished properly. But the general practice of over-feeding babies and children who are small and short but who are healthy with no sign of any disorders or diseases is, in the opinion of an increasing number of investigators, a mistake with immense public health implications.

The paradigmatic view among paediatric nutritionists is that it is best that babies be born relatively big, and that small babies, whose weight and growth velocity is below that generally accepted as healthy, should be fed additional food so that their height 'catches up'. This approach has mixed success in its own terms.

But when short children are given extra food they tend to stay short but become fat. Studies consistently show that rapid growth in height and weight, whether induced or not, promotes overweight in childhood, premature sexual maturity, and also future obesity, diabetes, coronary heart disease, and cancers of some sites (32-36).

## **Heart disease**

There is a solid consensus among epidemiologists that in high-income settings, being tall is protective against cardiovascular disease. Perhaps it is, but to my mind this finding is shaky. Tall people are at an advantage in many ways that are hard to disentangle from the effect of tallness *in itself*. Conversely, in high-income settings shorter people tend to be of lower social class, have less money, often eat unhealthily, and are less able to look after themselves and their families. In a society where shortness was valued and short people were generally at a social advantage, I doubt that this finding would hold.

Other findings show that the typical 'Western' diet promotes both tallness and heart disease (16,38). Ecological studies do not indicate any benefit of tallness for heart disease (13). In the early 1900s, heart disease was rare in North America and Europe. It increased sharply around the middle of the century. But the populations

concerned were shorter, not taller, at the beginning of the century. Women are shorter than men and have lower rates of heart disease than men.

Many populations with little to no heart disease are short. Thus, males in New Guinea, and in the Cook and Solomon Islands, Kalahari bushmen, and Congo pygmies, were practically free of heart disease when still following traditional ways of life. Other short populations with low heart disease when living traditionally include Kitavans, Yanomamo Indians, Vicabambians, Tarahumara Indians, and Inuits. By contrast, heart disease is common among tall European populations (13).

Among developed populations, Japan, Hong Kong, France, Portugal, Spain and Italy have had the lowest CHD mortality (13). All these populations are shorter than Northern Europeans who have substantially higher mortality rates. Support for smaller people having lower rates of heart disease also comes from animal data. Thus big tall dogs have six times the rates of heart disease compared with small dogs (12).

## **Cancer**

A comprehensive review of the literature shows that tall people are at greater risk of colorectal and breast cancer, and probably also pancreatic cancer. There is no evidence that tallness protects against any cancer (35).

## **Energy restriction**

For almost a century now, experiments have shown that energy restriction, which produces smaller animals, leads to less disease and longer lifespan (39). This is also found in monkeys (40). Preliminary studies indicate that humans on energy restricted diets show more healthy and youthful levels of various biochemical factors, including longevity-promoting lower insulin-like growth factor -1 (IGF-1), insulin, glucose, CRP and cell replication (2,41).

A study in Hawaii also found that elderly people lived longer if they consumed less energy, down to a level of less than 1000 calories a day (42). This empirical evidence is supported by an analysis, based on thermodynamics, which found that an 18 per cent reduction in caloric intake below the average population intake could, at least in theory, greatly increase human longevity (3).

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Data from the Great Leap Forward famine in China indicates that adults born during the famine were healthier and have lived longer than adults born after the famine (43). This goes against the widespread belief that restricted fetal nutrition and the resulting smaller infants produce less healthy adults. The US Great Depression also provides unexpected results. For example, US infants born during that time had the largest increase in life expectancy compared with more prosperous periods during the 20th century (44). Also infant mortality declined, as did mortality for most age groups. The reasons may well have been limited income resulting in reduced food intake, especially of non-essential and processed foods, and slower growth.

Additional support for the benefits of energy restriction comes from Japan. People on the island of Okinawa who have consumed their own traditional diets, consume fewer calories compared with mainland Japan, are smaller in height and weight, and are healthier and live longer. Okinawans born in mainland Japan are larger and less healthy than those born in Okinawa.

## **Biological mechanisms**

The findings above are epidemiological. Taken together they are good evidence, but such evidence is more convincing if backed by identification of plausible biological mechanisms.

One mechanism supporting the ‘shorter and smaller is better’ thesis is somatic cell duplication potential. Telomeres are tails at the ends of chromosomes that keep the chromosomes from unravelling. They shorten every time the cell duplicates itself. When telomeres get to a certain length, cells can no longer duplicate themselves. The fewer times a cell replicates itself during early life the more it can duplicate at older ages.

Bigger bodies use up more cell replications during their path to maturity, simply because they contain more cells. A bigger body also uses up more cell replications to maintain itself throughout life. Thus, telomere erosion is a major factor promoting ageing. Fewer replications are available in older age to replace damaged or dead cells (45).

Reviews of telomere shortening and its relation to longevity are producing evidence including from animal studies that this mechanism is indeed plausible (46,47).

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Human studies show that healthy centenarians have longer telomeres than unhealthy centenarians (46). Among 90 year olds, those who are shorter have longer telomeres and a better survival rate (47). Male and female babies have the same length telomeres, but in adulthood, smaller females have longer telomeres and live longer than males.

Several other biological mechanisms favour shorter body types, given the same body mass. These include lower blood pressure, increased heart pumping efficiency (48), lower left ventricular mass, lower left ventricular hypertrophy, and lower atrial fibrillation (24).

Except for the lungs and heart, the organs of smaller people are relatively larger in comparison with their body mass, given the same proportions (5). The organs of shorter people are under less functional load. Women have relatively larger organs compared with men, except for the heart and lungs.

Shorter, lighter people, consuming less food and drink, absorb fewer toxins and micro-organisms, which over time can have a negative impact on health and longevity. Also fewer free radicals are generated. As one example, 19 per cent taller people have 85 per cent higher DNA damage compared with shorter people (5,49). The fact that shorter people have less cells makes them less vulnerable to DNA and other cell damage that promotes cancer or other diseases.

Biochemical levels of harmful substances are also lower. As with people who restrict their energy intake, the biochemical profiles of small light people are healthy. They have lower cholesterol, insulin, insulin-like growth factor-1 (IGF-1), cystatin-C, C-reactive protein, and other undesirable substances. They also have higher levels of beneficial factors – sex hormone binding globulin, IGF-1 binding protein, adiponectin, and high-density lipoprotein (5).

## **Implications for public health nutrition**

I have been asked to say how the findings and the thesis briefly summarised in this commentary, impact on the teaching and practice of public health nutrition. One of the reasons the proposal that it is best to be short and small is resisted, sometimes vehemently, I feel has little to do with the nature, quantity and quality of

the evidence. Rather, it's because the thesis is a head-on challenge to the most basic tenet of nutrition since its beginnings as a modern science in the early 19th century.

In those days, with the Industrial Revolution in full swing, and with it the need to breed big tall strong young people to fight land wars and to work in factories, the need for accelerated human growth with all this has turned out to imply, was practically self-evident. The memory lingers on. Further, nutrition scientists now often insist that short small babies be over-fed, to 'catch up' their growth, despite the evidence that this generally doesn't work, and also that the effect is to promote overweight and obesity with all that follows.

So yes, with all great respect, I am proposing that nutrition science, in its present conventional form, goes right back to basics, examines the realities of the world we live in now, and works out whole new principles. Among these, I would like to suggest, are that nutrition now needs to be guided by ecological, evolutionary and environmental considerations. Even if it was true that being tall protected people now alive from chronic diseases, and increased their lifespan – and my reading of the evidence indicates that this is not so – the environmental argument for a shorter, smaller human world population is surely overwhelming. Here the evidence is totally on one side. The duty of all professionals with a commitment to the continuation of life on earth surely must be to a human race that treads less heavily on the planet.

#### *Box 2*

### **Tallness and shortness: Advantages and disadvantages**

#### **Advantages of being tall**

##### *Performance*

Taller people have greater strength and reach, run and swim faster, and jump higher and further. They can keep warmer in colder weather, due to a lower surface area to body mass ratio.

##### *Health, lifespan*

Taller people in high-income industrialised countries tend to have less cardiovascular disease and to live longer. Taller people tend to have lower resting heart rates. Their larger blood vessels may protect them from cardiovascular disease. Tall people with higher socioeconomic status are more likely to have a healthy weight, to follow healthy ways of life, and to have better medical care.

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#### *Social*

Taller people have social advantages. They are given more respect. In most countries now they are more likely to succeed in life. Women prefer taller men.

#### *Economic*

Taller people generally earn more money than shorter people. Executives tend to be taller than their subordinates.

#### **Disadvantages of being tall**

#### *Health*

Taller people are more likely to develop some common cancers.

#### *Environmental*

Taller populations require more resources. Food, water and energy needs are greater. Greater consumption means increased pollution and environmental damage.

#### *Economic*

Taller people consume more and so cost more. Their additional resource needs and environmental damage also increase economic costs.

#### **Advantages of being short**

#### *Performance*

Shorter people can lift their bodies more easily because they are stronger in relation to their weight. They also have faster reaction times and can accelerate and rotate faster than taller people. They are more agile and have more endurance.

#### *Health, lifespan*

In many settings shorter people live longer. Most centenarians are short. Shorter populations from lower-income, non-industrialised countries generally have much lower coronary heart disease and stroke.

#### *Environment*

Smaller people need less food, water and other resources. Other things being equal, they generate less waste and create less pollution and ecological damage.

#### *Economic*

Because shorter people require less of virtually everything, they cost less.

### Disadvantages of being short

#### *Performance*

Shorter people cannot lift as heavy objects as taller ones. They have a shorter reach. They are slower swimmers and runners, except for long-distance running.

#### *Health, lifespan*

Shorter people tend to have higher heart rates.

#### *Social*

In many countries and settings there is prejudice against short people.

## Conclusions

In some ways tall people are at an advantage. In other ways they are at a disadvantage. The same applies to short people. An overall judgement depends on what factors are considered relevant and of these, which are considered to be most important. If the only factors taken into account are biological, and specifically risk of chronic diseases and lifespan, within high-income industrialised countries taller people are on the whole at an advantage, though they are more likely to suffer some cancers. If a broader view is taken, tall people perform better in some ways, and short people perform better in other ways.

If economic and environmental factors are taken into account, the story is different. Other things being equal, smaller populations consume less, and need less of practically everything. The environmental case for physically short and small populations is overwhelming. In most parts of the world it is generally thought that tall people are superior. This view is not well founded on science. Prejudice against short people is objectionable. It is also unwise.

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### *Key Terms*

Height, body size, nutrition, ecology, pollution, resources, rapid growth, obesity, longevity, chronic diseases, cancer, heart disease, centenarians, caloric restriction, biological mechanisms and ageing, telomeres.

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