Longevity perspective

Do short and slim people live longer? An engineering perspective

Dr. Ram B. Gupta, Professor of Chemical Engineering, Auburn University, Auburn, USA

Does one's height and weight influence how long one will live? With the availability of the unbiased data in the last decade, now this question can be answered. A very striking feature is the lower life expectancy of men when compared to women. Men are 8% taller than women, but women live 7.9% longer than the men (Samaras et al., 2003). Also, mortality is correlated to the height in a recent study conducted to examine six ethnic groups living in California (Table 1).

Table 1. All-cause mortality among people of different ethnic groups in California (Wild et al., 1995).

Ethnic group	*Average Height*	*Deaths per lakh population, during 1985-1990*
Japanese	5' 6.4"	675
Chinese	5' 6.6"	760
Indian	5' 7.0"	650
Hispanic	5' 7.6"	890
White	5' 10.1"	1200
Black	5' 10.1"	1800

Clearly, the taller ethic groups have higher mortality. The highest mortality is in the Black ethnic group which has both high height and high weight.

A person can have short height due to childhood illnesses (for example, stunted growth due to stomach illness by Helicobacter pylori, poor nutrition, etc.) or due to genetics. Analysis in this essay deals with the short height due to genetics; that is comparing people who have been exposed to similar living conditions but have differing heights.

Other than the all-cause mortality, deaths due to some illnesses are also related to height. For example, occurrence of cancer is found to be proportional to the height of the adult. According to a recent study (Gunnell et al., 2001), taller people experience 20-60% more cancer than the shorter people. In a Norwegian study involving about 5 lakh women, it was found that the tendency for breast cancer increases with height. Similar results were also seen in American Cancer Society's study of 4 lakh women for breast cancer.

When comparing different ethnic groups, some of the ethnic groups (e.g., Indian) with shorter height have a higher occurrence of coronary heart disease, mainly due to narrower arteries. A different picture is seen when people are analyzed inside a single ethnic group. For example, among European males only, it was observed that deaths due to coronary heart disease increases with the height (Table 2).

Table 2. Deaths due to coronary heart disease in European males 45-65 years of age (Schmidt, 1995).

Country	*Male height (inches)*	*Annual deaths per lakh of population*
Portugal	64.9	140
Spain	65.0	140
Italy	65.7	200
France	66.3	120
Belgium	67.3	225
Switzerland	67.4	170
Germany	68.2	260
Denmark	68.4	335
Netherlands	68.6	275
Sweden	69.0	310
Norway	69.1	360

Effect of weight on life expectancy is even greater than that of height. It is well known fact that the overweight people have lower life expectancy. In today's literature, a lot has been written about obesity and its severe consequences to human health and increased mortality. Either weight (or mass) or the height alone are linked to lower life expectancy, but when both are high the life expectancy drops significantly, as inferred from the mortality of Blacks living in California (Table 1). It appears that the loss in the life expectancy comes from much more than the additive effects of weight and height.

From an engineering view point can a theory be put together to explain about the fact that the short and slim people live longer? The two factors (height and weight) can be combined into one, as the potential energy (*PE*) of the person. Potential energy is given by the product of the mass and height as

PE = (mass of the person in kg) x (height in meters/2) x (9.81)

Here for simplicity, the center of gravity of a person is assumed to be at the mid height and gravitational pull is 9.81 m/sec^2. If the clinical data is now compiled in the form of *PE* versus mortality, effect of height and weight can be merged into a single variable *PE*. A low *PE* would present a high longevity and vice versa.

Above inverse correlation of *PE* to longevity makes sense when one considers that a heavy or tall or heavy-tall person has to maintain a high potential energy to carry out the functions of life (such as, standing, walking, getting up, etc.). This imposes an extra load on the person, which can cause significant wear over the whole life, resulting in early death.

According to thermodynamics, nature prefers to lower its energy states, because the lower energy states have higher entropy. Hence, nature always functions so that the energy state is lowered by its actions (for example, heat flows to lower temperatures, objects fall downwards to lower their potential energies). Upon death, a person reaches his or her lowest potential energy state (as dead bodies are not able to pull themselves against gravity). Hence, death results in lowering of the potential energy, which is preferred by the nature. Hence, the nature puts an extra effort in bringing down people with high *PE*, because every such death will result in a significant lowering of the potential energy. So according to thermodynamics, a person with higher *PE* will have a lower life expectancy.

Now consider species that live in water. For such animals effective gravitational pull or the potential energy is significantly less due to the presence of the buoyancy. Hence, the revised *PE* formula for such species is

PE = (mass of the person in kg – buoyancy effect) x (height in meters/2) x (9.81)

For animals living in water, *PE* values are very small, because the body density for most animals is close to that of water. Perhaps that is why many of the water animals enjoys a high longevity. For examples, there are documented cases of turtles and alligators living in excess of 500 years.

Similarly reptiles that have a very low center of gravity (i.e., height) are known to live a long life. On the other hand, flying species such as birds, mosquitoes, and butterflies have short lives as their center of gravity is maintained very high from the earth's surface, resulting in high *PE*.

So what are the implications of above theory for human longevity? Low *PE* for humans can be obtained if they reside in zero or micro-gravity (in space), or in low gravity (on Moon or Mars). But at present mortality data for such life styles are not available. Nonetheless, the theory presented here provides a hope for a higher longevity for space residents. For the residents of Earth, theory may have implications when considering house floor plans; it is yet to be analyzed if multi-floor plans lead to higher mortality when compared to people living in single-floor plan houses.

References

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