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Meeting the Food Needs of the Ageing Population – Implications for Food Science and Technology

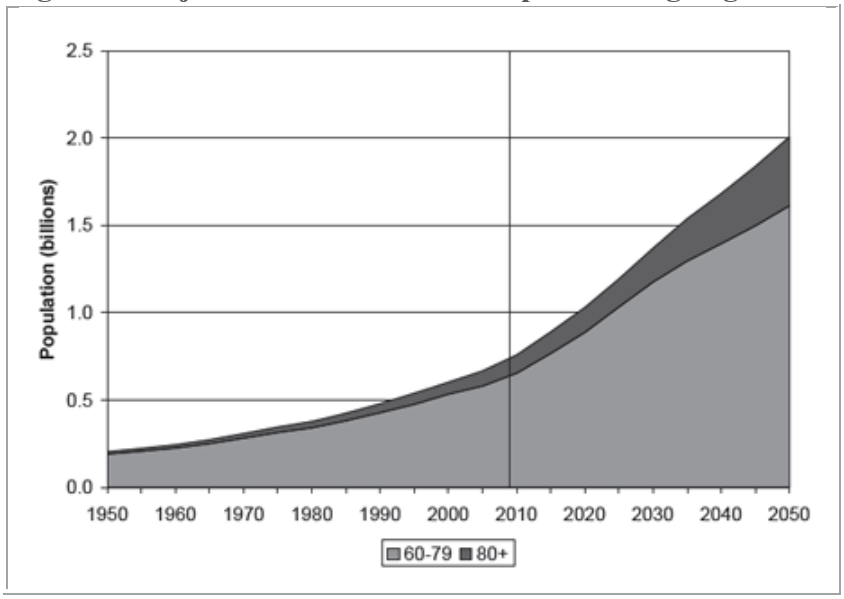
Over 65 Year Olds – An Overlooked Segment of the Population

The fastest growing segment of the global population is the one that has to date largely been overlooked by the food industry and relatively few food and drink products have been actively targeted to these ageing consumers (Costa & Jongen 2010, Hensel 2012). The majority of new products that are introduced are positioned to a younger demographic – the principal grocery shopper aged 21 to 49 years – under the premise that marketers are interested in securing product adoption at a younger age. The potential market for food products for older consumers over 65 years who represent the single fastest growing demographic in the food industry worldwide remains largely ignored. There are significant opportunities for the food industry to look to an older demographic population for product insights and to develop products to meet the wide variety of needs that this population offers.

Global Growth of the Over 65 Segment

The world population from 2000 to 2050 is projected to grow by 54% from 6.0 B to 9.3 B (US Census Bureau). The global population of those aged 65 or over will grow at more than four times this rate. Whereas those aged 60 or greater numbered 0.6 B in 2000 this age group is projected to grow to 2 B by 2050 or more than triple the current number (Figure 1).

Figure 1 Projected Acceleration of Population Ageing



Source: United Nations, 2009

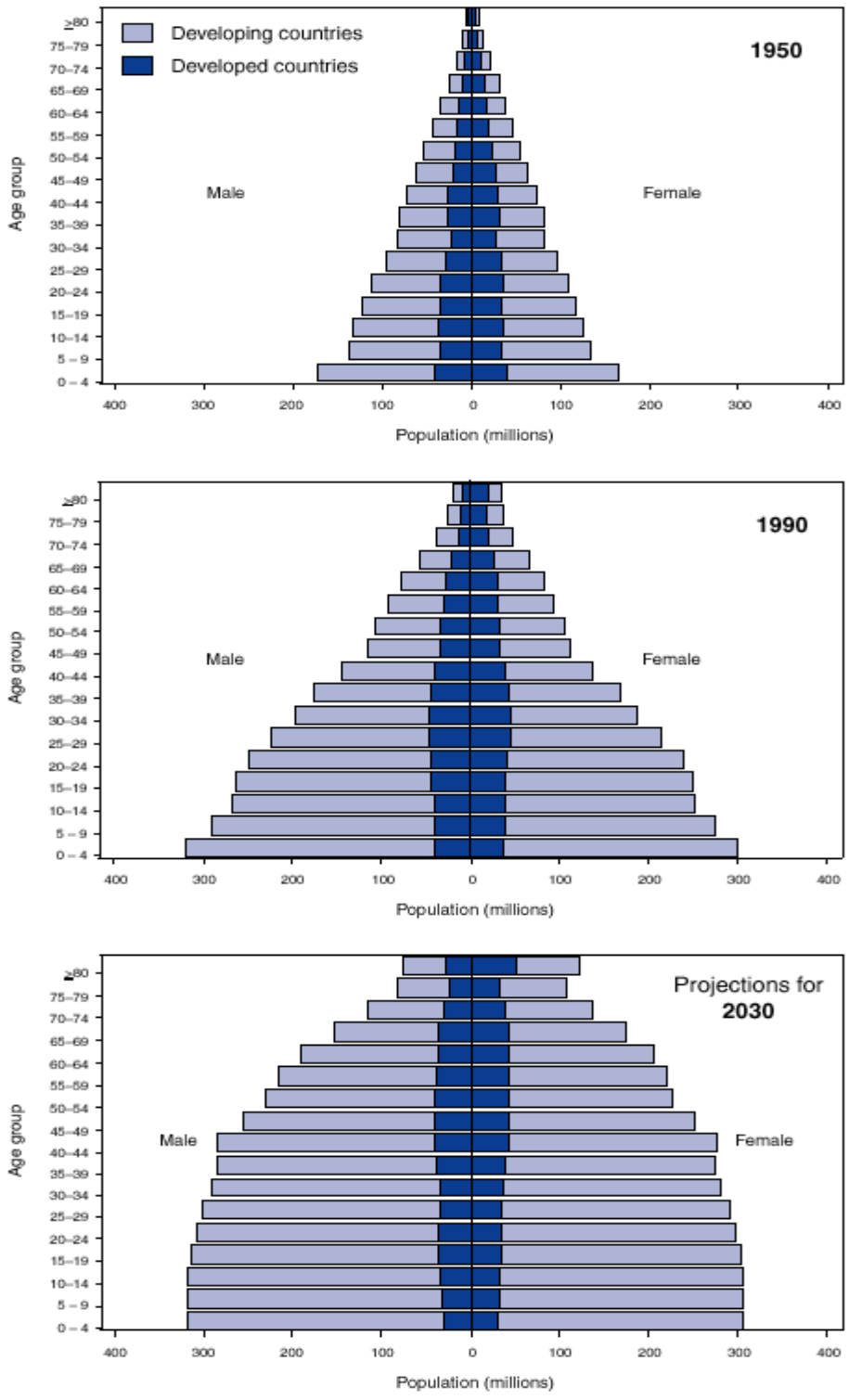
Somewhat surprisingly this dramatic growth in the elderly population is a global phenomenon and is not just restricted to the developed world. In fact in absolute numbers the greatest growth of those 65 or over will be in developing nations. For the years 2000 to 2030 , whereas the 65 or older group is projected to grow from 420 M to 973 M globally, in developing nations it is projected to grow from 249 M to 690 M a near tripling in numbers versus developed nations growing 171 M to 283 M. (Goulding and Rogers 2003)

No other demographic is growing faster globally and no other demographic in the developing world is growing faster. By 2030 those age 65 or older will account for 24.3% of the population in Europe and 20.3% in the US. Although the proportions of 65 plus are lower in developing countries they are growing faster due to the sheer size of the overall population growth. Another measure of the growing importance of this age segment is the relative size of the seniors group to the typical working population. In that regard in the years 2000 to 2030 the ratio of seniors-to-working population is projected to grow from 21% to 33% in the developed world and from 8% to 13 % in the developing world (Gribble and Jacobsen 2010). To further illustrate the point the US itself will see this senior-to-working age ratio grow from 21% to 37% from 2005 to 2050. Over the same time period China will see this ratio grow from 12% to 43% and Korea will grow from 16% to 70% exceeding the ratio in the US (Turner 2006). Thus the ageing demographic will have relatively an even greater impact on the developing economies of the world.

In many countries of the developed world, the post-war baby boom generation (those born in the 20 years after 1946) has been the subject of much marketer attention as this group came of age in the 1960's and 1970's, raised their families in the 1980's and 1990's and is now headed into its retirement years in the 2010's and 2020's. This well documented and much discussed bulge in the demographic absolutely pales in comparison to the huge demographic tsunami that is about to hit the developing world. Figure 2 demonstrates just how large the impact of this ageing demographic will be.

Figure 2

FIGURE. Population age distribution for developing and developed countries, by age group and sex — worldwide, 1950, 1990, and 2030



Source: United Nations, 1999, and U.S. Bureau of the Census, 2000.

Driving the growth of the 65 plus demographic is growing life expectancy. In the thirty years from 1970 to 2000 life expectancy has grown by 5 years from 69 to 74 in the developed world and by 10 years from 54 to 64 in the developing world (Edwards 2010). Although the developing world still lags behind the developed world in absolute life expectancy the gap is narrowing with ever improving economies, education, and healthcare. Life expectancy in affluent societies has steadily increased due to nutrition, vaccination and public health initiatives. If the increase in life expectancy in developed countries achieved over the past two centuries continues through the 21st century, most babies born after the year 2000 in Europe, the USA, Canada, Japan, and other countries will live to celebrate their 100th birthday. Present evidence suggests that people are not only living longer than they did previously, but also they are living longer, with less disability and fewer functional limitations (Christensen 2009).

Both the dramatic growth of people reaching age 65 years and their increased life expectancy up to 100 years plus has resulted in a classification system for those aged 65 years and older into three sub populations referred to as:

The "Young - Old" 65-74 years
The "Old or Middle - Old" 75-84 years
The "Oldest-Old or Old - Old" 85+years

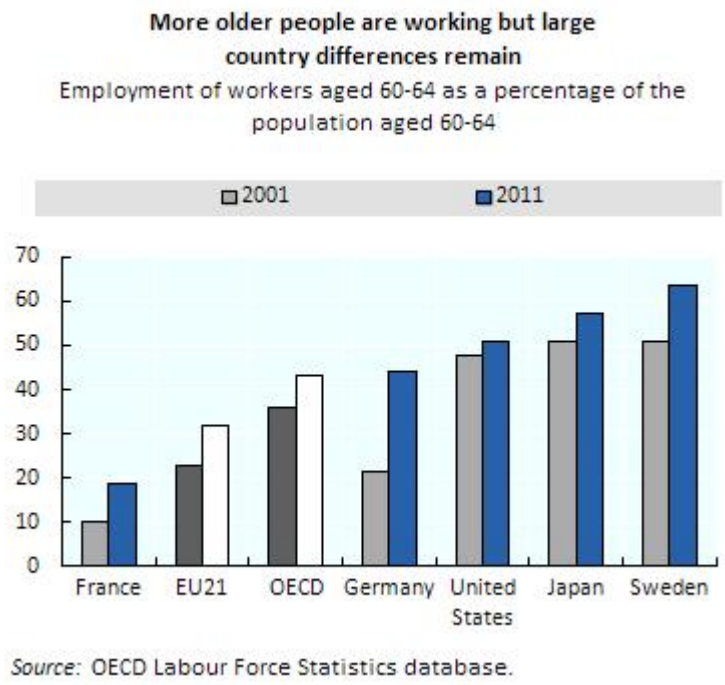
Retirement Age is Increasing

Of particular relevance to the Young – Old population are factors related to the onset of retirement as well as the potential for an extended time in the work force. Both scenarios have implications for the purchasing power of this population for groceries and out of home food.

Germany became the first nation in the world to adopt an old-age social insurance program in 1889, designed by Germany's Chancellor, Otto von Bismarck. The idea was first put forward, at Bismarck's behest, in 1881 by Germany's Emperor, William the First, in a ground-breaking letter to the German Parliament. William wrote: *". . . those who are disabled from work by age and invalidity have a well-grounded claim to care from the state."* Initially Germany set age 70 as the retirement age and subsequently lowered it to 65 in 1916.

In most developed countries, as tracked by the OECD, the average retirement or pensionable age is 65. Whereas the effective retirement age in these countries (that is, the age of a person leaving the labour market) had been steadily declining that trend has reversed in the last ten years. In 1970 retirement age averaged 67, declined to 63 in 2000 but has now risen to 64 in 2010 (OECD 2006). The rise in the working elderly can be seen in Figure 3.

Figure 3



Ageing in Place

The rapid growth of the ageing population has implications for the provision of sufficient, safe and appropriate living accommodation. Quality of life, according to the elderly, is linked to their health, family and social networks, home and independence (Tinker et al., 2004). Ageing in place in a safe and secure environment is an optimum solution. The elderly are not one homogeneous population. In addition to having greatly varying abilities and disabilities, their cultural, ethnic, class, and gender differences mean that 'one-size-fits-all' solutions will not work. A wide range of practical and policy solutions, with many different nuances, will be necessary in order to meet functional needs and enhance the quality of life for all elders (Burgess et al., 2006).

There are implications for satisfying the varied food needs of the ageing consumer who lives in his or her own home. The needs range from the most active consumer who desires and is able to shop personally for his or her own food supplies and prepare meals, to the house bound consumer who requires home delivery of food supplies and prepared meals including specialised diets. With enhanced internet usage and availability there are opportunities to streamline the process for catering to the in home consumer. In a critical review by Costa & Jongen (2010) a consumer-led approach to the development of ready meals for the ageing population is outlined and recommended for Home Meal Replacements for senior households.

Perception and Liking of Foods with Age: Sensory Impairment of the Older Consumer

The ageing process is accompanied by decreased efficiency in sensory perception, which is defined as the combination of olfaction (smell), gustation (taste), textural and trigeminal senses (touch or pain), vision (sight), audition (hearing), and kinesthesis (body movements). This is how

an individual receives information about a food's flavour, temperature, colour, appearance, and texture. This functional decline is supposed to lead to a decreased palatability of food and a failure to develop sensory-specific satiety (Rolls 1993, Morley 1997). Although the decline does not affect all senses and consumers in the same way, the heterogeneity in effects of ageing has been found for all senses.

Taste

The structural basis of impaired taste perception in normal ageing is poorly understood. Not many anatomical changes have been observed in the taste system with ageing. In the past it was thought that taste loss with increasing age was caused by a decrease in the overall number or density of taste papillae or taste buds. However, using more precise techniques, Seiberling & Conley (2003) found very little or no loss of taste buds. The possibility remains that age-related taste impairment arises from changes in the replacement rate of taste cells or from changes in the taste cell membrane, i.e., ion channels and receptors (Fukunaga 2005).

It is still unclear, whether and also to what extent the perception of taste diminishes with age. Roughly half of the researchers did find diminished sensitivity with age for at least one taste quality when the tastants were dissolved in water (Drewnowski et al., 1996, Mojet et al., 2003). However, most authors found no or little age effect once the tastants were embedded in food products (De Graaf et al., 1994, Feeny et al., 2011). Mojet et al., (2003) found that the intensity ratings decrease with age for all ten tastants she used (for salty, sweet, sour, bitter and umami taste each two tastants) dissolved in water, but only for the sweet and salty tastants dissolved in product. Moreover, in studies in which taste intensities were assessed in aqueous solutions as well as in product, only poor correlations were found between the results for the two different conditions (Drewnowski et al., 1996, Mojet et al., 2005). These last authors reported that when tastants were dissolved in real food products the impairment of taste could be attributed for 92.4% to a generic age effect and for 5.6% to a basic taste specific age effect. However when nose-clips were worn, only 12.1% was due to a generic age effect and 60.8% basic taste specific and 12.4% tastant specific. Hence, the authors concluded that the young make use of their sense of smell in taste perception and that the elderly, due to olfactory impairment (see below), can do so to a lesser extent. Thus, reported impairment of taste perception with age might largely be caused by age-related losses in olfaction. Another interesting finding these authors and Williams & Hertlein (2012) confirmed was that the elderly were at least as good as the young, if not better, in detecting intensity differences, which might be the source of complaints when products are changed over time by the manufacturer.

Smell

The impairment of olfactory perception as a result of ageing has been described by a number of authors for both aqueous solutions and food products. The elderly perceive the odours not only as less intense (Wysocki & Gilbert 2006, Aschenbrenner et al., 2007, Schubert et al., 2012), they also experience more difficulties in odour identification (Cain et al., 1990, Larsson et al., 2000). Under continuous odour exposure, elderly are more prone to olfactory adaptation and their sensitivity recovers slower than that of young subjects (Stevens et al., 1989). Finally, measurements of brain activity in response to olfactory stimulation - olfactory event-related potentials (OERPs) - further support the psychophysical findings of impaired smell perception in the elderly (Murphy et al., 1994, Covington et al., 1999). The elderly were found to have smaller amplitudes and longer latencies than the young. Nevertheless, it cannot be completely ruled out

that smaller amplitudes and longer latencies might be a general characteristic in the elderly, rather than a sign of specific deterioration.

The olfactory bulb is one of the sites in the human brain where early changes appear that are related to neurodegenerative diseases such as Parkinson's and Alzheimer (Kovacs et al., 2001, Katzenschlager & Lees 2004). In summary, olfactory impairment as a result of ageing seems to be multifactorial, with changes seen in the composition of the olfactory epithelium, in cell numbers, in the cilia function, and intracellular changes as well as neural responses.

Influence of impaired olfaction on quality of life has not yet been unraveled. Fischer et al., 2009 found no significant association between losses of smell and quality of life or dietary choices. The results were confirmed by Schubert et al., 2012. Landis et al., 2010 studied the interaction effects of decreased olfaction and taste in a population of 210 normosmic and hyposmic subjects and found that long term impaired olfaction was associated with a decreased gustatory function, irrespective of age, which might explain the occurrence of co-existence of both impairments. This finding supports the finding of Mojet et al., (2003) that taste perception is at least partly dependent on smell perception.

Touch, Vibration and Pain

Little is known about the effect of age on oral tactile and/or temperature perception. Ageing modifies various aspects of oral physiology such as dental status, bite force, saliva composition or muscle fatigue (Ship 1999), which in turn may influence somatosensory perception. Dental status and oral health are assumed to be the factors with the highest impact on oral tactile perception as dental integrity is directly related to masticatory performance. Elderly, especially those with partial or complete dentures, may suffer from impaired masticatory efficiency. However, healthy elderly easily compensate reduced masticatory efficiency by changing their chewing behavior, such as increase of chewing frequency and duration (Kohyama et al., 2002, Mioche 2004). Furthermore, other oral sensations, such as vibratory and thermal sensations, were found to remain relatively stable with ageing, showing only a slight decline in function after age 80 (Calhoun et al., 1992) and no significant age-associated deterioration was observed in spatial acuity of touch sensations in the anterior tongue (Fukunaga et al., 2005).Thus, it seems that oral tactile and temperature perception is relatively well preserved in the elderly. The influence of age on the perception of oral and/or nasal pain (irritation) has been examined in only a limited number of studies to date. In oral irritation perception, no age-related change in thresholds of capsaicin has been observed (Fukunaga et al., 2005), whereas declines with age in intranasal irritation sensitivity at supra-threshold levels were reported (Stevens & Cain 1986, Hummel et al., 1998, Frasnelli & Hummel 2003). In addition, the elderly were found to perform poorer in the discrimination of different irritants than did the young (Laska 2001). In general, compared to young subjects, the elderly showed higher pain thresholds for similar painful experiences, but they had a lower pain tolerance (Gagliese 2009). Loss of natural denture does not seem to have an effect on pain thresholds (Blanchet et al., 2008).

Swallowing

The two key determinants of safe swallowing are proper bolus formation and appropriate tongue and oral pressure to move the bolus down the oesophagus. The amount of saliva determines bolus formation so reduced saliva production among the elderly which is estimated as 30% of the population over 65 years (Turner 2007) can lead to increased choking hazard. Bolus size on

average is about 2 g although it varies with number of chews (typically 8-15 chews before swallowing). Based on the type of food the bolus can consist of up to 50% saliva hence the importance of saliva or other moisture to bolus formation.

Tongue pressure is generally unvaried with age among the adult population under 65 (at about 50 kPa) but deteriorates with age to about half that (about 20-30 kPa) by age 80 (Chen 2012). This is significant because the tongue pressure required to initiate swallowing is about 30-40 kPa. Thus many elderly may have trouble initiating swallowing. The sensory perception of food increases with the number of bites and time in the oral cavity. So the flavour perception among the elderly might be comparable to younger individuals where longer chewing times leads to food lingering longer in the mouth thereby building flavour perception.

Vision

Starting around their forties, people need higher levels of illumination, greater degrees of contrast between objects and their backgrounds, and they will find it harder to accommodate, i.e., to rapidly focus on objects at different viewing distances. As focusing becomes more difficult, vision may become increasingly blurred and fuzzy. There is often less depth perception, less tolerance to glare, and distinguishing colours may become more difficult (Mendez et al., 1996). Inadequate lighting and colour contrast between the table top and the dinnerware can result in problems that lead to inadequate nutritional intake (Koss & Gilmore 1998, Calkins & Brush 2002). The use of colour and colour contrasts specifically, was found to be effective not only for improving vision and clarity of the environment, but also in promoting better orientation, memory enhancement, a sense of safety and independence (Gohar 2008).

Audition

With age, the ear structures deteriorate. The eardrum thickens, which leads not only to a diminished hearing, but it can also affect balance adversely. Changes to the nerve may lead to difficulty in hearing high-frequency sounds (presbycusis). The sharpness of hearing may decline and the “cocktail party syndrome”, i.e., the phenomenon that in rooms where many people are talking, elderly people often have great difficulty listening specifically to the person who is speaking directly to them, may occur. A loss in hearing may take its toll in crispiness perception and the feeling of freshness. However, no reports on the influence of hearing loss on food texture perception have been found.

Liking

Until about ten years ago it was still widely assumed that age-related impairment in chemosensory acuity would inevitably lead to changes in food liking with increasing age and so would lead to modifications of elderly food choice and dietary behavior (see critical review by Mattes, 2002). This sequence of assumptions was based on the observation that sensory acuity diminishes with age and on several reports that elderly subjects expressed on average a preference either for higher stimuli concentrations in solutions or for stronger tasting/flavoured products (Pangborn et al., 1983, Schiffman & Warwick 1993). However, in these studies the relationship between impaired sensory acuity with increasing age and higher optimal preferred stimulus concentrations was demonstrated at a group level and not at an individual level and the actual sensory acuity of the subjects was measured in none of these studies.

Furthermore, ambiguous results were obtained in studies in which preference was assessed both in aqueous solutions and in products. On the one hand, elderly were reported to have age-related differences in preference both in water solutions and "real-life" products (Murphy & Withee 1986, Drewnowski et al., 1996). On the other hand, although the elderly still seemed to prefer higher stimulus concentrations in water, they were found to express preferences in "real-life" food products very similar to the young (De Graaf et al., 1994, Mojet et al., 2005b). A possible explanation for this latter observation could be that food liking in humans is learned and that as people grow older, they learn to associate the foods they like with different sensory signals. Thus, the elderly might be able to compensate for sensory losses with the help of earlier acquired product concepts and consequently might not require sensory product adjustments to maintain their food liking. Interestingly, no correlation was found between sensory acuity and hedonic responses, neither at a group level nor at an individual level (Issanchou 2004, Forde & Delahunty 2004). Thus, the sequence of assumptions that age-related impairment in chemosensory acuity inevitably leads to changes in food liking with increasing age and that this impairment leads to modifications of elderly food choice and dietary behavior lacks sufficient support.

In a study of food liking (Kremer et al., 2007) food liking was not increased by different compensation strategies such as texture change, flavour enrichment, flavour enhancement or addition of an irritant. These findings were confirmed by Essed et al., (2009), who reported that on a group level no effect of intake and liking of soup enhanced with mono-sodium glutamate and celery powder was found in the elderly. It is possible that the role of sensory compensation strategies towards improving food acceptance has been overestimated and that other age-associated factors such as eating alone, appetite and health issues merit more attention when considering the food intake needs of the elderly.

Nutritional Needs Change with Age

The nutritional needs of the elderly will change depending on age and health status. For many food categories today marketers focus their attention on lowering calories in their products to assist weight reduction strategies for their consumers. Obesity is undoubtedly a world-wide issue with 1 B of a 7 B population considered obese or overweight, but it is not predominantly the problem with the elderly population.

Humans tend on average to gain weight up to age 55 years, plateau and then start to lose weight age 65 years and beyond. This weight loss in the upper years may be up to 10% of the plateau level and is a function of reduced muscle mass, reduced height and reduced BMI (Halls 2013). Muscle mass grows with age, peaks in the fifties and then starts to decline in the sixties and beyond (Arts et al., 2009). Humans tend to lose height after their mid-fifties which affects body weight. Body Mass Index (BMI) tends to increase with age, plateau in the fifties and decline after the sixties. Thus after spending most of their adult life battling weight gain, by the sixties and beyond humans need to be thinking of preserving muscle mass and strength. Strong muscles are important to balance, walking, climbing stairs and the regular activity of life. As humans become more sedentary with age these muscles tend to atrophy unless exercised regularly.

Health Changes with Age

As humans age, the major health issues that emerge are the onset of chronic diseases. The increased proportion of chronic to acute diseases in the population is largely the result of the success of medical science which has extended life expectancy by helping humans survive the diseases that they would have succumbed to in the past, leaving more people to continue into older age with the concomitant onset of chronic disease and natural degeneration.

Most of the older consumers in the US have at least one of the following chronic conditions: 1.Arthritis (50%); 2. Hypertension (34%); 3. Heart disease (32%); 4. Cancer (23%); and 5. Diabetes (19%); (IFT 2012). King et al., (2013) reported that despite their longer life expectancy over previous generations, US baby boomers have higher rates of chronic disease, more disability, and lower self-rated health than members of the previous generation at the same age, although they are less likely to smoke cigarettes and experience lower rates of emphysema and myocardial infarction than the previous generation. Hurd et al., (2013) predict that the number of people with dementia in the United States will more than double within the next 30 years. Such findings point to the likelihood for continued rising health care costs and a need for increased numbers of health professionals as baby boomers age.

On a global scale, according to the World Health Organization (WHO 2011) the top four causes of death by non-communicable diseases (NCDs) are: 1. Cardiovascular diseases (47%); 2. Cancers (21%); 3. Respiratory diseases (12%) and 4. Diabetes (4%). These diseases share four risk factors: smoking, physical inactivity, alcohol use and unhealthy diets. They are often called the lifestyle diseases.

From Canadian data (Health Council of Canada 2011), 55% of the population at large have one or more chronic conditions. Among those aged over 65 this jumps to 81% and of hospital patients 100% have at least one chronic condition. Whereas in the general population 56% take prescription medications among the elderly 90% do. Expressed another way, whereas those over age 65 account for 13% of the general population they account for 52% of total hospitals days. Thus to the degree that general health and medication factors affect the eating experience the experience of feeding patients in hospital settings provides important lead indicators as to the special needs of the elderly.

Special Dietary Needs Change with Age

In Canadian hospitals where the average age is approximately 73 years, just over half (54%) of meals are regular meals (Healthcare Food Services 2011). The other half of meals require special diet considerations, namely diabetic diets (13%) texture modified diets, i.e., pureed or minced (10%) , heart healthy diets, i.e., low in fat, cholesterol and sodium (9%) with others such as Kosher, Halal, vegetarian, lactose free, low potassium - each below 1%.

In long term care facilities where the average age is older approximately 83 years, 50% of meals are regular meals but the remainder are primarily texture modified diets (40%) with the remainder of all diet types making up the remaining 10%.

Such market data suggest that, for the institutionalized market at least, about half of all food will have to be prepared to some special formula or texture for health or safe swallowing reasons. If that is indeed a precursor to the market in general then retail food marketers and developers will have to take into greater consideration the specific needs of the elderly population who continue to live at home in increasing numbers.

Preventive Measures

There is expanding evidence to support the idea that healthy ageing is affected by what humans eat. For example Belshaw (2012) showed that molecular changes to the genes of human volunteers, some of which are associated with cancer development, were mainly driven by ageing but were also affected by diet. Cognitive performance has been shown to be lowered by high sodium intake and less frequent exercise (Fiocco et al., 2011)

There is also increasing interest amongst consumers in accessing health benefits through food to maintain good health as they age (Hensel 2012). Several ingredients have been identified as benefits for improved memory and eyesight (Milo Ohr 2013)

Overall the most significant opportunities will be in the development of food products that have proven scientific beneficial health effects that are permitted by legislative bodies and are also understood and adopted by consumers. With advancing food technologies, the ability to extract, isolate and concentrate bioactive compounds from foods and other materials will spawn the development of functional food-based products and nutraceutical supplements.

Implications for Food Science and Technology

There is a significant body of documented research from several different fields notably gerontology, nutritional and medical sciences, social science, consumer and sensory science that combined can give insights to addressing the food needs of the ageing population. Sharing and exploring this information in a collaborative manner will result in solutions that will benefit the end users.

Ageing clearly has many effects on human capacity and is characterized by an increase in variability of capabilities, both within a population and within individuals. Thus, there is a greater variability in the capabilities of a group of elderly than in a group of young persons. Product developers have to keep the sensory losses older consumers experience in mind when (re)formulating their foods and beverages, while at the same time realizing that not all senses and consumers are affected in the same way. One size does not fit all!

To meet the needs of this diverse and rapidly growing population, food developers may take note of the following suggestions when developing food for the elderly population.

1. Realistic portion size - with a lowered appetite due to lower activity level, shrinking body weight, lower caloric requirement and general health level an average meal size for the elderly should be smaller than for the younger adult population.
2. Visualization of sizing – whereas for the general adult population large bulky portions connote value for money for the elderly a portion that is too large in appearance can be

intimidating. For this age group, especially the Middle-Old and Old-Old, eating can be a chore not a pleasure so a meal should look easy to eat.

3. Nutrient dense foods – whereas for the general adult population bulky low nutrient foods can promote satiety and help with weight loss the opposite is true for the elderly. With declining muscle mass and lower appetites foods for the elderly need to be dense in nutrients, such as protein, so as to provide the greatest nutrition per bite.
4. Micronutrient enhancement can be considered to compensate for reduced nutrient intake.
5. Flavour enhancement – although flavour perception declines with age avoid the obvious solution to develop flavour systems with enhanced flavours as there is little evidence to support the premise that older consumers want or like their food to be flavour enhanced.
6. Texture modification – since a larger portion of this elderly audience will have trouble chewing or swallowing increase the moisture level of the food to compensate for lower saliva production. Also make soft food available as bite size pieces so the food can be easily swallowed if need be without chewing or causing choking.
7. Compensatory strategies – with reduced motor skills and prevalence of arthritis, design the food to be easily handled, cut and eaten. A good rule of thumb is to design the food so that it can be eaten with a fork or spoon in one hand.
8. Packaging solutions – with more single person households among the elderly design single portion or smaller pack sizes. As well design the packaging graphics to be easily read with large fonts and high contrast and the physical package to be easy to open.

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