Age as a Predictor of Social Acceptance of Nanotechnology and Nano-Based Food: A Conceptual Framework

Jacob Oluwoye, PhD
Professor of Transportation and Environmental Health
CURR Director
Department of Community and Regional Planning
College of Agricultural, Life and Natural Sciences
Alabama A&M University, Normal, AL 35762
USA

Abstract

Research into acceptance of innovative nanotechnology foods by the aging population will provide insight into and add to the body of knowledge about factors that will predict acceptance of nano-based foods. This paper proposes a conceptual framework for age as a predictor of social acceptance of nanotechnology and nano-based food among metropolitan populations based on a detailed review of the existing literature. The conceptual framework comprises six public perceptions towards acceptance of nanotechnology foods: nanotechnology knowledge, social trust, perceived benefits, perceived risk, perceived naturalness, and demographics. The analysis of framework reveals the theory about the process by which individuals accept or reject new ideas or products that consists of three sequential steps: invention, diffusion, and consequences. Furthermore, the analysis also indicates that one way to cope with lack of knowledge is to employ social trust when assessing the risks of a new technology. The main conclusion that has emerged from this study is that nanotechnology provides vast opportunities for research because it is a new and developing concept. Worthwhile theoretical analysis and empirical research lie in proposing a broad model of age as a predictor of social acceptance of nanotechnology and nano-based food decision-making. It is envisaged that this theoretical model provides a useful tool for developing a more comprehensive overall social acceptance of nanotechnology foods strategy.

Keywords: Nanotechnology, Nanofoods, Public perceptions, Age, Social, Acceptance, Predictive

1. Introduction

Oluwoye (2008) reported that several countries around the world are facing the rapid aging of their populations over the next 40 years. This natural phenomenon is an irreversible outcome of a sustained period of low birth rates combined with continued longevity among older adults. As migration, except at a massive level, can have a minor effect upon the aging of the population, America's aging future can be predicted with a high degree of certainty, (Oluwoye, 2008).A major concern of American society today is the aging of its population and the special needs of that aging population. The United States Census Bureau (2003) describes aging as "a general term which can be defined as a physiological, behavioral, sociological or chronological phenomenon"(p.1). For statistical reporting purposes, the American Bureau of Statistics looks at aging by means of the chronological concept and further refines the categories into: 1) older population (age 55-64); 2) Elderly (age 65-74); and 3) aged (75+). Therefore, all persons over the age of 55 are considered to be part of the aging population. According to the United States Department of Commerce (2002), the median age of the United States (US) population was 35.3 years in 2000, the highest it has ever been, which reflects aging baby boomers. The World Health Organization (WHO) defines health as 'a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity'**.** Furthermore, there are many definitions of healthy aging, a term which is often used interchangeably with terms such as active aging (Bowling, 2008),(WHO,2002),successful aging (Bowling &Diepper,2005; Bowling & Iliffe, 2006; Rowe & Khan, 1997), positive aging (Kendig & Browing, 1997) and productive aging.

Although there is no universal definition there is general acceptance that healthy aging involves more than just physical or functional health. WHO defines active aging as 'the process of optimizing opportunities for health, participation and security in order to enhance quality of life as people age' allowing people to 'realize their potential for physical, social and mental well-being throughout the life course' (WHO, 2002). Poor nutrition and obesity are among the most important health issues facing society's today, not only in terms of health, but also health care expenses (Goel, 2006;Rashad&Grossman, 2004).There are a variety of predictors of obesity including genetics, the amount of physical activity, and food consumption(Goel,2006). There are other outcomes like food choice and nutrition that have an independent effect on health including some types of cancer, cardiovascular disease, and diabetes (Nicklas, et.al., 2001).Based on the above discussions, food selection is an important consumer behavior with many long-term consequences to the individual in the form of health and longevity, and to society in the form of health costs.

Historically, many technologies have been associated with societal controversies leading to public rejection of their use. It is therefore important to understand the psychological determinants of societal acceptance of emerging technologies. The quest for knowledge and scientific inquiry has driven humanity to explore developments in science and to apply them to human requirements and needs. The question now is what is technology and nanotechnology? Technology has been defined by Random House Webster's College Dictionary, 1997 as a technological process, invention or method, or "the application of knowledge for practical ends" or "the sum of ways in which social groups provide themselves with the material objects of their civilization," while nanotechnology is defined as using materials and structures with nano scale dimensions, usually in the range of 1-100nm (Masciangioli and Zhang, 2003; Roco, 2003). Furthermore, nanotechnology can be described as an emerging technology, and as has been the case with other emerging technologies such as genetic modification, different socio-psychological factors will potentially influence societal responses to its development and application. These factors will play an important role in how nanotechnology is developed and commercialized. Public rejection of technologies has frequently resulted in negative consequences for the commercialization of technologies. In particular, unpredicted events and accidents affecting the public have acted as a signal that has resulted in fear and reluctance to adopt certain technologies, and consumer rejection of the products of these technologies. Perhaps as a consequence, much of the research focused on understanding societal acceptance of technologies has been directed towards risk perception.

For example, is the market introduction of the first generation of genetically modified (GM) food crops, which led to polarized GM food debate internationally (Dale, 2004; Hall, 2007). The intensive societal discussion that followed was detrimental for the adoption and commercialization of GM crops and food products at least in some regions of the world (Aerni, 2005; Batrinou et al., 2005; Frewer, Scholderer and Bredahl, 2003; Klintman, 2002; Trait, 2001).The occurrence of such events and controversies over the use of technology, emphasize the importance of public acceptance in strategic development, application and commercialization of technologies. Nano technology is perceived as one of the key technologies of the present century. This technology has major potential to generate new products with numerous benefits. Nanotechnology is increasingly being employed in the areas of food production and packaging (Kuzma & VerHage, 2006; Sanguansri & Augustin, 2006).Food and nutrition products containing nano scale additives are already commercially available. It is expected that nano technology will become increasingly important in the near future. Historically, according to market analysts, the nanofood market had been expected to rise from7.0 billion US dollars today to 20.4 billion dollars in 2010 (Allianz & OECD, 2005). It was likely that public perception of nanotechnology would be crucial for the realization of technological advances (Macoubrie, 2006; Royal Society and Royal Academy of Engineering, 2004). Therefore, public attitudes toward nanotechnology should be taken into account at an early stage of technology development (Renn & Roco, 2006; Roco, 2003.

1.1 Purpose of the paper

The purpose of this paper is to develop a conceptual framework of age as a predictor of social acceptance of nanotechnology and nano-based food among metropolitan populations based on a detailed review of the existing literature. This paper is divided into four sections. The first is a detailed review of the previous studies. The second section presents a conceptual framework of public perceptions toward nanotechnology foods based on the findings of the previous studies. The third section discusses and analyses the components of the conceptual framework. Finally, the fourth section concludes the findings of the discussions in the earlier sections.

2. Previous Studies

In a published paper it was reported by Roco and Bainbridge (2001) that social acceptance, resistance, or rejection of nanotechnology is an important area for social science research and also explained that understanding and measuring the variable degree of social acceptance would be a necessity as new nanotechnologies are progressively introduced and readily available in the marketplace. Furthermore, Miller (2004) observed that there is a strong and continuing public belief in the value of scientific research for economic prosperity and for the quality of life in the US despite low civic scientific literacy percentage. In the survey conducted by Bainbridge (2002) where factors such as gender, age, education and political orientation were considered, majority of the respondent indicated an agreeable attitude towards nanotechnology. Similarly, Cobb and Macoubrie(2004) in their national phone survey of Americans' perceptions about nanotechnology observed a positive attitude notwithstanding expectation of both benefits and risks. The intricate relationships among heuristics and their influences on public opinion formation has been the focus of several studies. For example, the relationship between increasing awareness and public support for embryonic stem cell research was studied by Nisbet (2005) based on the indication from past research that "miserly" is the most likely stance of the public on controversial issues related to science and technology.

Results of the analysis of national survey data collected in the US during the fall of 2001 and the fall of 2002 indicates that the public relying on their underlying values and ideological predispositions tend to be miserly than fully informed as opinions are formed based on readily available information through the mass media and other information sources. Similarly, Scheufle and Lewenstein (2005) utilizing a national telephone survey on awareness and attitude toward nanotechnology, found that people form opinions and attitudes even in the absence of relevant scientific or policy-related information. The study noted that people will use cognitive shortcuts or heuristics, such as ideological predispositions or cues from mass media, to form judgments about emerging technologies. Earlier research on the decision making about scientific issues and emerging technologies has utilized either cognitive or affective factors as distinct influences that have different effects on public understanding of and public attitudes toward scientific breakthroughs. Later studies have begun to utilize the combination of these factors (Lee et al., 2005). However, studies on the public attitude towards emerging technologies such as those conducted by Miller (1998, 2004) could be classified under the cognitive explanation, which focuses on the link between science literacy and attitudes toward new technologies. It should be noted that either issue-specific knowledge or on more general scientific literacy has been the emphasis of the studies following this model.

The area of risk perceptions and risk communication is often where studies of issue-specific knowledge about new technologies are conducted. Hornig (2003) in the evaluation of technological risk laid the first (1) assumption that specific risks can be accurately and objectively calculated. The second (2) assumptions is that individuals' risk perceptions are at least to some degree a function of pre-existing levels of knowledge about the topic could be noted in the study of Wildavsky and Dake (1990). Emphasis on more general scientific literacy likewise assumes that knowledge of basic scientific ideas and concepts is a prerequisite for a range of science-related behaviors and attitudes, such as informed public decision making (Miller 1987, 1995, 1998, 2004) or support for science (Miller and Kimmel 2001; Miller, Pardo, and Niwa, 1997; Shen, 1975). Its difference from the previous, emphasizing on more general scientific literacy assumes that citizens have various levels of understanding when it comes to the scientific process, the idea of scientific inquiry, and related concepts (Lee et al., 2005).Meanwhile, affective factors to explain people's decision making about scientific issues and emerging technologies has been the focus of the research conducted by Priest (2001), Priest et al, (2003) and Siegrist (1999, 2000). Concerns or fears as affective aspects are said to have more influence on people. Affective factors are more of a function of the potential severe outcomes or of the vividness of potential risks rather than of objectively quantifiable probabilities or expectations (Lee et al., 2005). Smith et al, (2008) developed a model of nanotechnology risk perception change, specifically with regard to gender differences. Individuals who changed from being unable to discern the balance of risks and benefits to believing that benefits outweighed risks or risks outweighed benefits as shown by the model can be accurately depicted through consideration of their gender, their education level attained, and, most interestingly, their political party. Particularly, results showed differences between the male and female gender. Notwithstanding, the awareness, factual knowledge, opinions, and risk perceptions of students from Turkish middle schools with regard to nanotechnology in a very general sense was examined by Sahin and Ekli (2013) surveying students in grades 6-8.

Results showed that for gender, no significant difference was observed, while for some of the demographic and affective domain factors, and achievement in science courses, significant differences were found.

3. Theoretical Conceptual Model

Oluwoye (2008) reported that Rogers and Shoemaker (1971) have described and tested a theory about the process by which individuals accept or reject new ideas or products. The theoretical framework for this study will have as a basis the theory of social change and adoption as proposed by Rogers and Shoemaker. This theory has been used extensively as the basis for testing the acceptability of innovative products or ideas that can apply to the innovative nanotechnology and nano-based food alternatives to be addressed in this study**.** This theory consists of three sequential steps: invention, diffusion, and consequences. Alternative food, particularly the innovative type in this study, can be categorized under the first step of invention. The invention step, involves proposal of a new product or idea, and does not ensure societal acceptance. Diffusion is the process by which information about the innovations is spread to other members of a social system. Despite generally favorable attitudes toward technology and change in the United States, a considerable time lag exists from the introduction of an innovative idea to its widespread adoption. Nanotechnology innovations have lagged behind innovations in other fields. The third process of the social change theory is consequences. What happens following invention and diffusion? Is the idea or innovation accepted or rejected?

According to Rogers (1962) innovations are not immediately adopted following their invention. Rather there are many stages through which one moves in the adoption process. These stages are as follows:
Awareness- the individual is exposed to the innovation.

Interest- the individual becomes interested in the innovation and seeks new information.

Evaluation- the individual mentally applies the innovation to his present and anticipated future situation and then decides whether or not to try it.

Trial- the individual uses the innovation on a small scale to determine its utility for personal use.

Adoption- the individual decides to continue full use of the innovation.
In 1983, Rogers proposed a model of the innovation decision process that consists of five stages, knowledge, persuasion, decision, implementation, and confirmation.

The basis for the innovation-decision process is that there is a process individuals experience as they pass from first discovering an innovation knowledge to forming an attitude toward the innovation persuasion, to adopting or rejecting and innovation decision to utilizing the innovation implementation and finally to verifying acceptance or rejection of the innovation confirmation. The knowledge stage is impacted by prior conditions of the person socioeconomic characteristics and an awareness of needs among others. The persuasion stage involves the perceived characteristics (compatibility, complexity, trial ability, and observably) of the innovation. In the decision stage which is a mental process either acceptance or rejection of the innovation occurs. The implementation stage is not passive but active the person actually uses the innovation. The final stage confirmation is one during which individuals reinforce the decision they originally made to use the innovation. The diffusion stage describes how knowledge of the innovation is spread. Weber, McCray and Claypool (1985) have taken the basic theoretical model of Rogers and Shoemaker and adapted it for use in analyzing data regarding the propensity of individuals to adopt innovative housing. Weber et al. (1985) stated that the process by which innovative housing is diffused through society in relation to the diffusion process is relatively unknown. The theoretical framework of Oluwoye (2008) Rogers (1962, 1983) and Rogers and Shoemaker (1971) of the adoption process of innovations is the foundation of this research study.

3.1 Proposed Conceptual Model

The proposed conceptual model (fig,1) shows how the investigators will examine the endogenous and exogenous variables. The basic premise of this model is that acceptance of nanotechnology and Nano-based food can be predicted by the nanotechnology knowledge, social trust, perceived benefits, perceived risk, perceived naturalness, demographics and age.

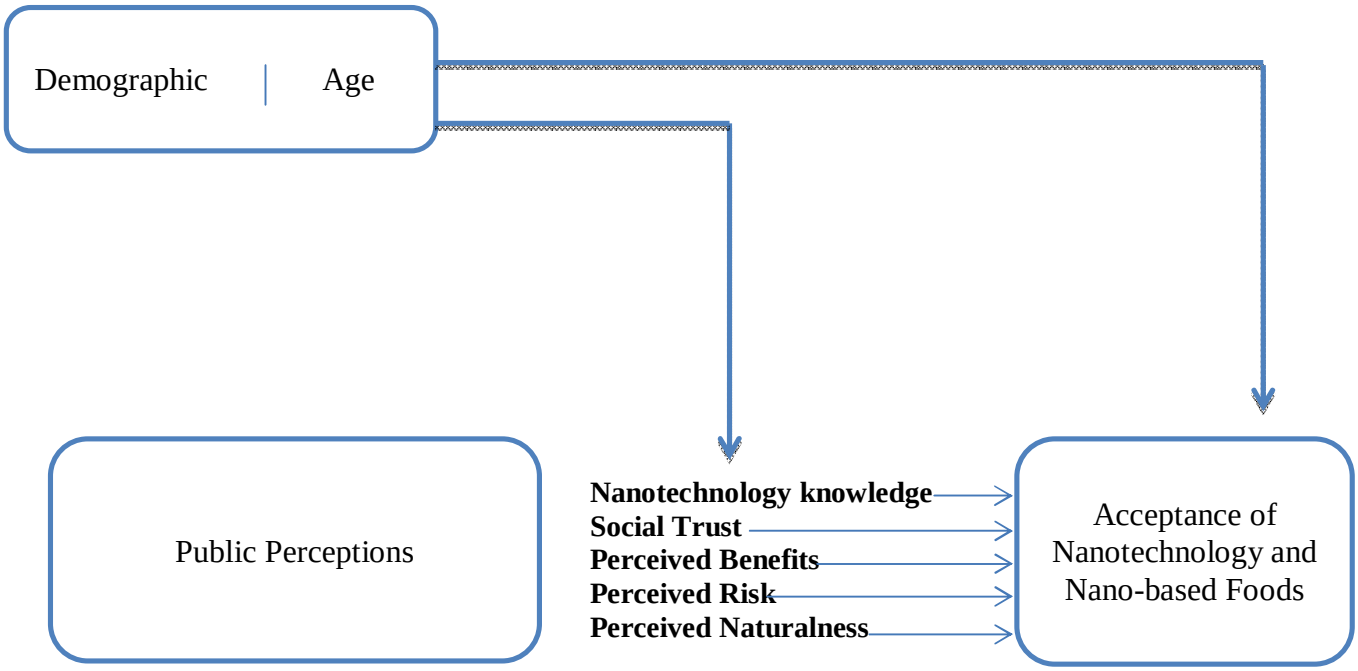

Figure 1: Proposed Conceptual Model of Public Perceptions toward Nanotecnology and Nano-based Foods adapted from Oluwoye (2008)

4. Analysis of Framework

This section discusses the key societal acceptance factors of the conceptual framework of age as a predictor of social acceptance of nanotechnology and nano-based food in detail. It analyzes the relevance of these factors by drawing on existing research work. Most people are not familiar with the term nanotechnology (Cobb & Macoubrie, 2004; Gaskell et. al., 2005).One wayto cope with lack of knowledge is to employ social trust when assessing the risks of a new technology (Siegrist & Cvetkovich, 2000). Research in the domain of gene technology showed that people who trusted in stitutions involve dinusing or regulating gene technology attributed more benefits and fewer risks to this technology (Siegrist, 1999, 2000; Tanaka, 2004). Acceptance of, or willingness to buy (WTB), GM foods is directly determinedly the perceived risk and the perceived benefit. In other words, trust has an indirect impact on the acceptance of GM foods. Nano technology foods may be more acceptable to consumers who perceive tangible benefits. Results of a Swiss study suggested that acceptance of GM products was largely determined by perceived benefits (Siegrist, 2000).

A Swedish study reported similar findings (Magnusson & Hursti, 2002).Tangible be nefits—products that are better for the environment, *Public perception* refers to the conscious understanding that people have of public and official issues. There may be a basic disparity between the factual truth and their virtual truth influenced by the public opinion and the mass media. The question now is "what are the factors influencing public perception?" This needs to be answered for more understanding of nanotechnology and nano foods. Public opinion or perception is largely influenced by media and public relations. The mass media uses various advertising techniques to convey their message and influence the thoughts of the people on important issues. People's opinions depend on various factors such as their immediate situations, their social factors, and their already existing knowledge and system of beliefs and values. Opinion leaders who speak out on popular issues have a major role in influencing public perception about them.

4.1 Public Perception towards Nanotechnology Knowledge

As the name implies, nanotechnology is a technology on the scale of nanometers, or billionths of a meter. With nanotechnology, natural resource wealth of the world can be value-added in order to win the global competition for the country. By creating substance to measuring one-billionth of a meter (nanometers), the nature and function of these substances can be changed as desired. Knowledge is a familiarity, awareness or understanding of nanotechnology, such as facts, information, descriptions also knowledge can refer to a theoretical or practical understanding of a nanotechnology.

4.2 Public Perception towards Nanotechnology Social Trust

Trust is a construct that has been developed in the social sciences, Earle (2000) reported that many trust researchers accept some version of the definition offered by Rousseau et al. (1998): "Trust is a psychological state comprising the intention to accept vulnerability based upon positive expectations of the intentions or behavior of another" (p. 395). According to the affect heuristic, affect evoked by nanotechnology products influences risks and benefits associated with this technology (Finucane, Alhakami et al., 2000). Due to the fact that nanotechnology is a very recent technology about which the public is not very well informed, participants must be given information about specific nanotechnology foods. Without additional information, the unfamiliar term nanotechnology may not evoke meaningful associations. Trust may influence how this information is interpreted. Therefore, we assumed that trust in the food industry has an impact on the affect evoked by the information material about the nanotechnology food.

4.3Public Perception towards Nanotechnology Benefits

Perceived benefit refers to the perception of the positive consequences that are caused by a specific action. In behavioral medicine, the term perceived benefit is frequently used to explain an individual's motives of performing a behavior and adopting an intervention or treatment. Researchers and theorists attempt to measure positive perceptions because they believe that a behavior is driven by an individual's cognition in terms of acceptability, motives, and attitudes toward such behavior, especially if positive. Nanotechnology and the use of nanoscale materials is a relatively new area of science and technology, and the public's benefits perception of such applications must be in evitable weighed against its possible adverse effects. The potential benefits of nanotechnology include the use of nonmaterial's in products to make them stronger, lighter, and more effective.

4.4 Public Perception towards Nanotechnology Risks

Perceived risks are a situation of the level of uncertainty of a consumer regarding the outcome of buying nano foods he/she will be worth it or not. Rosa (2003) defined risk as "a situation or an event where something of human value (including humans themselves) is at stake and where the outcome is uncertain, p56." It should be noted that psychological uncertainty is closely related to risk and is found in many theories of behavior. Furthermore, several previous studies, such have examined public perception of nanotechnology in the US and in Europe such as Cobb and Macoubrie, (2004); European Commission, (2001); Lee et al., (2005).

4.5 Public Perception towards Foods that Natural

The concept of naturalness is one of the more studied concepts in landscape preference research and describes how close a landscape is to a perceived natural state. In social acceptance of nanotechnology and nano foods study, one needs to explore the relationship between food preference and indicators of naturalness.

4.6 Demographic characteristics/Age

Demographics is interested in any population characteristic that might be useful in understanding what people think, what they are willing to buy and accept nanotechnology and Nano-based foods. Furthermore, demographic characteristics are population characteristics such as age, sex, etc. that will be used in demography to develop a demographic profile of social acceptance of nanotechnology and Nano-based food among metropolitan population.

5. Summary

The paper constructs a conceptual framework for age as a predictor of social acceptance of nanotechnology and nano-based food and discussing the relevance of six essential public perception factors (i.e.nano technology knowledge, social trust, perceived benefits, perceived risk, perceived naturalness, demographics and age). These public perception factors are derived from a detailed review of the existing literature on social acceptance of nano-food. It is envisaged that the conceptual framework will form the underlying basis towards the development of a more comprehensive model in future. The present study takes the approach of proposing a theoretical framework which can be applied to practical situation in the nanotechnology and nano food industry by reviewing available literature. Such research approach is common, particularly when existing knowledge in the particular area is still narrow. The present study, hence contributes to the advancement of the literature on nanotechnology and nanofood. As discussed, the present study represents the starting point for more future research. Nanotechnology provides vast opportunities for research because it is a new and developing concept.

Worthwhile theoretical analysis and empirical research lie in proposing a broad model of age as a predictor of social acceptance of nanotechnology and nanofood decision-making.

References

Allianz, &OECD. (2005). Opportunities and risks of nanotechnology. Munich: Allianz.

Aerni P (2005) Stakeholder attitudes towards the risks and benefits of genetically modified crops in South Africa. Environmental Science and Policy 8(5): 464–476.

Bainbridge, W. S. (2002). Public attitudes toward nanotechnology. Journal of Nanoparticle Research,4(6), 561-570.

Batrinou AM, Dimitriou E, Liatsos D, and Pletsa V (2005) Genetically modified foods: The effect of information. Nutrition & Food Science 35(3): 148–155.

Bowling, A., Enhancing later life: How older people perceive active ageing? Aging and Mental Health, 2008. 12(3): p. 293-301.

Bowling, A. and P. Dieppe, What is successful ageing and who should define it? British Medical Journal, 2005. 331: p. 1548-1551.

Bowling, A. and S. Iliffe, Which model of successful ageing should be used? Baseline findings from a British longitudinal survey of ageing. Age and Ageing, 2006. 35: p. 607-614.

Cobb, M., and J. Macoubrie. 2004. Public perceptions about nanotechnology: Risks, benefits, and trust. Journal of Nanoparticle Research: An Interdisciplinary Forum for Nanoscale Science and Technology 6 (4): 395–405.

Dale PJ (2004) Public-good plant breeding: What should be done next? Journal of Commercial Biotechnology 10(3): 199–208.

Earle, T.C., 2000. Trust in risk management. A model based review of empirical research. Risk Anal. 30 (4), 541–574.

European Commission, 2001.Eurobarometer survey on Europeans, science and technology. Brussels: European Commission.

Finucane, M. L., Slovic, P., & Mertz, C. K. (2000). Public perception of the risk of blood transfusion. Transfusion, 40, 1017–1022.

Frewer LJ, Scholderer J, and Bredahl L (2003) Communicating about the risks and benefits of genetically modified foods: The mediating role of trust. Risk Analysis 23(6): 1117–1133.

Gaskell, G., Ten Eyck, T., Jackson, J., Veltri, G., 2005. Imaging nanotechnology:

cultural support for technological innovation in Europe and the United States. Public Understanding of Science 14 (1), 81–90.

Goel, R.K. (2006). Obesity: An economic and financial perspective. Journal of Economics and Finance, 30, 317-324

Hall C (2007) GM technology in forestry: Lessons from the GM food "debate". International Journal of Biotechnology 9(5): 436–447.

Hornig, S. (1993).Reading risk: public response to print media accounts of technological risk. Public Understanding of Science, 2(2), 95-109.

Kendig, H. and C. Browning, Positive ageing: facts and opportunities. Medical Journal of Australia, 1997. 167(8): p. 409.

Klintman M (2002) Arguments surrounding organic and genetically modified food labelling: A few comparisons. Journal of Environmental Policy & Planning 4(3): 247–259.

Kuzma, J., &VerHage, P. (2006). Nanotechnology in agriculture and food production.

Washington, DC: Woodrow Wilson International Center for Scholars.

Lee, C. J., Scheufele, D. A., & Lewenstein, B. V. (2005). Public attitudes toward emerging technologies examining the interactive effects of cognitions and affect on public attitudes toward nanotechnology. Science communication, 27(2), 240-267.

Macoubrie, J. (2006). Nanotechnology: Public concerns, reasoning and trust in government. Public Understanding of Science, 15, 221–241.

Magnusson, M. K., & Hursti, U. K. K. (2002).Consumer attitudes towards genetically modified foods. Appetite, 39(1), 9–24.

Masciangioli, T., Zhang, W.-X., 2003.Environmental technologies at the nanoscale. Environmental Science and Technology 37 (5), 102–108.

Miller, J. D. 1987. Scientific literacy in the United States: Communicating science to the public.

New York: John Wiley.

———. 1995. Scientific literacy for effective citizenship. In Science/technology/society as reform in science education, edited by R. E. Yager, 185–204. New York: State University of New York Press.

———.1998. The measurement of civic scientific literacy. Public Understanding of Science 7: 203–223.

———.2004. Public understanding of, and attitudes toward, scientific research: What we know and what we need to know. Public Understanding of Science 13:273–294.

Nisbet, M. C. (2005). The competition for worldviews: Values, information, and public support for stem cell research. International Journal of Public Opinion Research, 17(1), 90-112.

Oluwoye, J.O. (2008) "A Conceptual Framework of Policy/Actions for Age as a Factor in Predicting Alternative Housing Needs among Non-Metropolitan Populations" published in the International Journal of Interdisciplinary Social Sciences .Vol. 3

Priest, S. H., H. Bonfadelli, and M. Rusanen. 2003. The "trust gap" hypothesis: Predicting support for biotechnology across national cultures as functions of trust in actors. Risk Analysis 23(4): 751–766.

Rashad, I., and Grossman, M. (3004).The economics of obesity. The Public Interest, 156, 104-112.

Renn, O., &Roco, M. C. (2006). Nanotechnology and the need for risk governance. Journal of Nanoparticle Research, 8, 153–191.

Roco, M. C. (2003). Broader societal issues of nanotechnology. Journal of Nanoparticle Research, 5, 181–189.

Royal Society and Royal Academy of Engineering. (2004). Nanoscience and nanotechnologies: Opportunities and uncertainties. London: Royal Society.

Rowe, J. and R. Khan, Successful aging. The Gerontologist, 1997. 37(4): p. 433-440.

Sahin, N., &Ekli, E. (2013). Nanotechnology awareness, opinions and risk perceptions among middle school students. International Journal of Technology and Design Education, 23(4), 867-881.

Sanguansri, P., & Augustin, M. A. (2006). Nanoscale materials development a food industry perspective. Trends in Food Science and Technology, 17, 547–556.

Satterfield, T., Conti, J., Harthorn, B. H., Pidgeon, N., & Pitts, A. (2012). Understanding shifting perceptions of nanotechnologies and their implications for policy dialogues about emerging technologies. Science and Public Policy, scs084.

Scheufele, D. A., & Lewenstein, B. V. (2005). The public and nanotechnology: How citizens make sense of emerging technologies. Journal of Nanoparticle Research, 7(6), 659-667.

Siegrist, M., Cvetkovich, G., 2000. Perception of hazards: the role of social trust and knowledge. Risk Analysis 20 (5), 713–719.

Rousseau, D.M., Sitkin, S.B., Burt, R.S., Camerer, C., 1998. Not so different after all: a cross-discipline view of trust. Acad. Manag. Rev. 23, 393–404.

Siegrist, M. 1999. A causal model explaining the perception and acceptance of gene technology. Journal of Applied Social Psychology 29:2093–2106.

———. 2000. The influence of trust and perceptions of risks and benefits on the acceptance of gene technology. Risk Analysis 20:195–203.

Smith, S. E. S., Hosgood, H. D., Michelson, E. S., & Stowe, M. H. (2008).Americans' nanotechnology risk perception. Journal of Industrial Ecology, 12(3), 459-473.

Tanaka, Y. (2004). Major psychological factors affecting acceptance of gene-recombination technology. Risk Analysis, 24, 1575–1583.

Trait J (2001) More Faust than Frankenstein: The European debate about the precautionary principle and risk regulation for genetically modified crops. Journal of Risk Research 4(2): 175–189.

Wildavsky, A., & Dake, K. (1990). Theories of risk perception: Who fears what and why? Daedalus, 41-60.

World Health Organisation. About WHO: Definition of Health. 2012 [cited 2012 24/01/12]; Available from: https://apps.who.int/aboutwho/en/definition.html.World Health Organisation, Active Ageing: A Policy Framework. 2002: Geneva: World Health Organisation.