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Research Article

Facilitators and Barriers to Fruit and Vegetable Consumption: A Qualitative Study of the Perceptions of the Public and Experts/Policymakers

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Abstract

Purpose: To map perceptions and knowledge among the public and experts/policymakers regarding the low levels of fruit and vegetable consumption in Bangladeshi society, and to identify the facilitators and barriers to increasing the consumption of these food sources.

Design/Methodology/Approach: The empirical investigation involved two specific groups: the public and experts/policymakers. Interviews were conducted with expert/policymaker key informants, and focus groups were organized with the public in selected rural and urban areas of Bangladesh. Thirty public-consumers aged 18 and over, and seven expert/policymaker key informants. Using the results of these sessions, a modified mental model approach was employed to help formulate perception and knowledge models, and pertinent juxtapositions were identified.

Findings: The public relies on first-hand experience, while the experts/policymakers depend more on scientific-technical knowledge. Additionally, the public holds several misconceptions relating to the recommended daily intake of fruits and vegetables, as well as food safety concerns. Furthermore, the experts/policymakers are inclined to suggest a 'one size fits all' solution that is likely not appropriate for the Bangladeshi context.

Practical Implications: Considerable perceptual gaps exist between the public and experts/policymakers regarding the low levels of fruit and vegetable consumption in Bangladesh. Thus, experts/policymakers must work to improve communication with the public, as this will lead to greater engagement and, consequently, the formulation of more effective policies for increasing fruit and vegetable consumption in Bangladesh.

Originality/Value: This study fulfils an identified need to study the facilitators and barriers to fruit and vegetable consumption in the face in increasing non-communicable diseases in Bangladesh, and identifies the existing gaps in knowledge and perceptions of the public and experts/policymakers.

Keywords: Fruits and vegetables; Food habit; Consumption; Vitamins; Minerals; Protein; Meat; Fish; Bangladesh

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Introduction

For centuries, the main function of food was to satisfy hunger; in the present day, food is a vital contributor to physical wellbeing, a major source of pleasure, worry and stress, and, worldwide, the single greatest category of expenditure [33]. Significantly, food is alsowidelyrecognized as being a critical contributor to good health. However, changes in diet over the past 40 years have had a negative effect on people's health worldwide, especially in Low- and Middle-Income Countries (LMICs), resulting in an epidemic of obesity and Non-Communicable Diseases (NCDs), such as heart disease and diabetes. Indeed, modern dietary practices are the main driver of the increasing prevalence of obesity and Non-Communicable Diseases (NCDs). A survey of the global literature reveals that these dietary changes have been profoundly influenced by the globalization of the market economy [29] and the accompanying spread of the 'Western' diet, which is predicated on large amounts of livestock, dairy products, fats, and oils, and fewer staple foods such as fruits and vegetables [17].

As the globalizations process since the 1990s brought the local Bangladeshi economy closer to the international economy, primarily through trade liberalization, it also affected a change in the dietary pattern. According to Vepa [42], there are three expected outcomes of globalization on food intake: i) shifts from cereal to more protective foods, i.e. meat, fish, fruits and vegetables, ii) shifts towards more processed food, and iii) rise of transnational fast food industry. The nutrition transition theory proposes that trending globalization along with an economic growth will shift the diet from minimally processed staple to highly processed foods, meat, and diets high in vegetable oils [7,30,31]. This rapid change in diet towards highly processed food is the major contributor to the rising trend of non-communicable diseases in LMICs [19,34]. It is suggested that that without considerable policy interventions, this trend of increasing processed food consumption is likely to continue [23].

Since many diseases are directly related to diet, it follows that dietary changes can play a key role in reducing the severity of a disease. As such, government policy, marketing campaigns, and interventions by private sectors and NGOs have all been deployed to promote the consumption of healthy foods in countries around the world. Unfortunately, our understanding of how to encourage more healthy eating behaviours among humans is still very poor, a fact that has been acknowledged by the World Health Organization (WHO) [5]. The World Health Organization recognizes that our understanding of how to change human behaviour towards healthy eating is still very poor [43].

One of the main barriers to promoting healthier eating habits through intervention is gaps in communication between experts/policymakers and the public. In the fields of health and the environment (i.e., climate change, cardiovascular disease control), the literature on risk perception and risk communication cites gaps between experts and the public, particularly as they relate to knowledge, attitudes, and perceptions [9,36]. There have always been gaps in understanding each other between the scientists, policymakers and the public. Scientist usually tend to regard the policy processes as politically motivated and are not scientifically evidence-based [40], while policymakers perceive scientists as rigid groups in applying methods, and myopic in scope [18]. However, policymakers and the scientists both have a consensus in that the public are often driven by emotion without assessing the facts and figures [22,32,35]. Notably, the public criticize scientists for taking a narrow (silo) perspective and using unintelligible scientific language and allege that the policymakers are usually too cautious to act on anything driven by mass sentiment [6,32]. One of the most popular methods for addressing such communication problems is the mental model approach, which was first applied for this purpose by Morgan and his colleagues [24] almost two decades ago. The general principle of this model, as formulated by Craik [4], is that the opinions and perceptions of experts are rational, standard, superior, and more correct compared to those the layperson [37]. In earlier versions of the mental model, scientists/experts were considered to be knowledge producers or validators, whereas the public comprises the 'political world', operating in the societal complex. Consequently, scientists and/or experts are the spokes persons of 'rationality', while the public and policy are considered 'emotional and political', and thus, inferior [6,22]. Notably, the literature contains no reports of the use of a mental model to investigate the gaps in communication between the experts and the public regarding low fruit and vegetable intake.

Nonetheless, a modified mental model was applied in a recent study [3], which produced findings that challenged the conventional belief that learning flows only from the expert to the layperson. These results were supported by those of several alternative studies, which found that experts may be 'cognitively handicapped' with respect to understating a layperson's limitations in receiving and processing knowledge [13]. These findings imply the existence of not only communication and knowledge gaps between the knowledge provider and the receiver, but also limitations in understanding each other's perspectives and comprehension abilities.

Against this backdrop, we explore the similarities and differences in the knowledge, attitudes, and perceptions of experts/policymakers and the public that hamper the effectiveness of interventions, as well as the formulation of policy and behavioural-change tools. Specifically, this study aims to map the public's and expert/policymakers' perceptions of and knowledge about fruit and vegetable consumption in Bangladeshi society, and to identify the facilitators and barriers to increasing the consumption of these food sources.

The 'Mental Model Approach' In Food and Nutrition Studies

Environmental and health problems are often a direct result of human decisions and actions. As such, these problems can be addressed via social-science constructs like attitudes and behaviours. However, the mental model approach is a unique tool, as it helps to predict the outcome or explore the cause-effect relationships between the concerned variables under study. The mental model approach is most popular in cognitive science and psychology, where it is described as the 'internal' representation of the 'external' reality [4,14]. As one of the major challenges of using the model is finding a way to illustrate the results of the analysis, different visualization techniques are generally applied in different fields of study (e.g., organizational research, risk communication, and education) [21,24,39].

The gap between the experts/policymakers' messaging and the general public's response was identified much earlier in the risk-communication literature [24]. To address this problem, Morgan and his co-researchers (2002) formulated a mental model that compared an 'expert model' and a 'public model' in order to 'map' the gaps between them and develop effective intervention tools. This elicitation technique was also employed

in the Carnegie Mellon University-based mental model methodology, which suggested developing an 'influence diagram' to illustrate expert opinions [3]. The initial influence diagram was developed based on the beliefs, values, and attitudes of experts as recorded in a Focus Group Discussion (FGD) setting. The 'expert model' was considered the standard that was to be compared with the public or other community models during final analysis. In a nutshell, mental model can identify and dissolve misconceived "public ideas" for the expert/policymakers to reconsider [10]. The mental model approach has been adopted in many fields, including natural resources management, environmental studies, and risk communication, to explore similarities and differences between the understandings of various stakeholder groups, to integrate the perspectives of different communities, or to identify misconceptions and barriers against behavioural change [1,24,28]. Nonetheless, the application of the mental model approach in the field of food and nutrition has yet to be explored, especially in the context of public health issues.

Materials and Methods

Setting and Study Plan

This study is part of a multi component initiative by the International Development Research Centre (Ottawa, Canada) aimed at investigating fruit and vegetable consumption and NCDs in Bangladesh. A total with a distribution of 62% rural and 38% urban population influenced the researcher to investigate the locational differences as they represent distinct characteristics (The World Bank, 2019). The focus of the IDRC project was to explore the prevalence and dietary risk factors (e.g. lower consumption of fruits and vegetables) associated with NDCs among the various segments of populations (urban, rural and indigenous people) in Bangladesh. Sylhet division was selected for the rural and indigenous representations and Dhaka for the urban dwellers for the baseline survey. However, in the present study no indigenous respondent was interviewed. Study areas for the qualitative study were selected using a simple random procedure from the IDRC baseline survey.

A total of three *Upazilas* (sub-districts, which are the third tier in a four-tier hierarchical administrative system) and the capital city of Dhaka South were selected following a simple random sampling procedure. These spatial units represented primary producers in agriculture and retails businesses in rural areas, and service sectors and other quaternaryoccupations in urban areas. The sampling frames of the Upazilas in two districts were obtained from the Bureau of Statistics, Government of Bangladesh, and for the City of Dhaka South was from the City Corporation Authority. The selected areas included the Borolekha and Kamolgonj *Upazilas* from the Maulovibazar District and the Derai *Upazila* from the Sunamganj District and four wards (new ward numbers 1, 11, 40, and 41) from the City Corporation of Dhaka South.

Participants

This study utilized a qualitative design consisting of four Focus Group Discussions (FGDs) and seven Key Informant Interviews (KIIs) aimed at understanding the barriers and facilitators to the consumption of fruits and vegetables in Bangladesh. Field data were collected by the first author between October 2018 and December 2018 with the verbal consent of the participants, which was provided at the time of collection. The Key Informant Interviewees (KIIs) and the participants of the Focus Group Discussions (FGDs) represnted two major stakeholder groups: i) consumers, and ii) experts/policymakers. The consumer group (i.e. buyers of fruits and vegetables) was selected randomly from the IDRC Project baseline survey. People affiliated with food-supplying jobs or the food-policymaking process were excluded. Policymakers were chosen from a wide range of government departments and reputable organizations in the field of agriculture and food policy formation and implementation.

All recruited participants were over 18 years of age, with most being women (4 males and 26 females). This asymmetry in the sample was primarily due to the unavailability of males during the daytime interviews and FGDs. The mean age of the participants was 40.3 years. In terms of religious background, the sample was almost equally divided between Muslims (n=14) and Hindus (n=16).The majority of the participants were housewives (n=18), while the remainder consisted of farmers (n=6), day labourers (n=3), small business owners (n=2), and a driver (n=1).

The key informants (n = 7) interviewed for this study included five government department specialists (science and technology, food safety, nutrition, agriculture, and agricultural extension), one agricultural economist from Bangladesh Agricultural University, and one supply chain specialist from Hortex (a private-sector company). Individuals were selected from different pertinent sectors to provide a range of expertise in the fields of horticulture cultivation, training, policy, and implementation.

The FGDs were held in the participants' houses or the courtyards in which they lived. The FGDs and KIIs were led by a facilitator, and a rapporteur was present to take notes and assist the facilitator where necessary. All discussions were held in the local language of *Bangla*, audiotape recorded (with the participants' consent), transcribed, and translated to English by the facilitator with input from the rapporteur.

Community members who were producers and consumers were engaged to represent the public in the formation of the 'public perception and knowledge model', and specialists and policy executives were engaged to form the 'expert/policymaker perception and knowledge model'. The community members (i.e., the public) were invited to reflect on their knowledge, attitudes, and practices relating to their fruit and vegetable consumption, meal composition in their households, their household decisions regarding meal choices, major barriers to accessing fruits and vegetables, steps that could be taken to increase fruit and vegetable consumption, and other factors affecting their food intake.

The second cohort of participants, consisting of seven experts/policymakers, shared their perceptions and knowledge relating to appropriate methods of eating fruits and vegetables and related cooking procedures, major barriers preventing adequate consumption of fruits and vegetables, and how to increase the public's consumption of these food items.

Data Analysis and Model Construction

All participants provided written or verbal consent, and all interviews were transcribed verbatim from audio recordings and checked for errors by the field research team. The transcripts were classified based on the broad categories of themes, major topics, and the interview guidebook. A final review of the emergent themes was conducted by the first author. Finally, the patterns that emerged from the tabulation of the qualitative data were structured into multiple tables for analysis (Table 1).

Table 1: Emerging themes and sub-themes from the FGDs and KIIs.

	Public Perception and Knowledge Model	Expert/Policymaker Perception and Knowledge Model
Theme 1	***Why and how to eat fruits and vegetables***	
	Lack of knowledge	Scientific knowledge
	Cooking preference	Cooking procedure
Theme 2	***Barriers to eating fruits and vegetables***	
	Taste preference	Historical preference
	Social events and family influence	Dysfunctional market influence
	Superstitions in food culture	Westernized food culture
	Formalin in fruits and vegetables	Misconception of pesticides and formalin use
	Price of safe vs. unsafe food	
Theme 3	***Ways and means to increase consumption***	
	Home-based gardening	Protective cultivation
	Collective awareness within family	Awareness raising about the benefits of consuming fruits and vegetables
	Community-level awareness	Privatization of the market
		Ending the formalin myth

Data analysis was conducted at the group level and thematic analysis was used to identify emergent themes from both the FGDs and KIIs. This study did not follow a typical mental model approach; rather, it was inspired by its attributes. While the development of a mental model generally requires a 'public model' and an 'expert model' with a series of steps of direct or indirect elicitation (i.e., a diagrammatic representation of interviewees' responses) to formulate the 'influence diagrams', we emphasized the participants' narrative descriptions of the concerned variables or items.

In this study, the causal relationship between the experts and the public was not controlled. Instead, we followed an indirect elicitation that consisted of semi-structured interviews with the experts/policymakers and FGDs with the public separately. The data obtained from the experts/policymakers and the public were formulated into an 'expert/policymaker perception and knowledge model' and a 'public perception and knowledge model'. Each model was thematically organised under three sections: i) why and how to eat fruits and vegetables; ii) barriers to eating fruits and vegetables; and iii) means to increase fruit and vegetable consumption. Finally, the gaps and juxtapositions between the models were identified and analyzed.

Ethics Approval by Institutions

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the University of Manitoba Joint Research Ethics Board, Winnipeg, Canada (Ref. Protocol J2018:044 (HS21997). Further institutional approval of ethical research protocol was obtained from the Bangladesh Medical Research Council, Dhaka, Bangladesh (Ref. BMRC/NREC/2016-2019/673). Written informed consent was obtained from all voluntary participants before filling the questionnaires and/or prior to collecting data. In order to ensure data confidentiality, no personal identifiers were collected.

Results

The patterns in the field data revealed three main themes relating to fruit and vegetable consumption: i) why and how to eat fruits and vegetables; ii) barriers against fruit and vegetable consumption; and iii) methods and means for increasing fruit and vegetable consumption. According to these themes, we developed two separate public and expert knowledge models.

Public Perception and Knowledge Model

The results of the public perception and knowledge model are summarized in (Table 2) and the analysis is presented below.

Table 2: Public Perception and Knowledge Model.

Theme	Sample of comments made by the public participants
Why and how to eat fruits and vegetables	*"To fulfill the body's nutritional needs; to regain strength to work the next day; and to accelerate 'brain development of children' so they can perform well in school."*
Barriers to eating fruits and vegetables	*"If the bitter gourd looks too green, it has formalin. If it looks a little less bright, it has no formalin. That's the one I buy."*
	"Vegetable consumption increases in the family after having kids. But the kids don't eat much; the mother eats more vegetables after birth because she needs more energy to keep up with the children."
Ways and means to increase consumption	*"Men's duty is to increase production or to buy the product at the right time; children's duty is to tell what their preferences are; women's duty is to collect the vegetables from their surroundings or to tell their male counterpart what to buy based on the taste of all household members, as well as to cook accordingly."*
	"Children follow what their parents are eating, so parents need to eat healthy food."

Theme 1: Why and How To Eat Fruits and Vegetables

Lack of knowledge: All four FGDs (three in rural areas and one in an urban area) began by exploring the importance of eating fruits and vegetables. Most respondents agreed when a participant opined that:

'Fruits and vegetables were important for meeting the body's nutritional requirements, for helping them to regain strength so they could return to work the next day, and to accelerate the 'brain development of children' so they perform well in school.

Regarding the question of how often or how much fruits and vegetables one must eat, most participants in rural Kamolgonj *Upazila* indicated that:

'We did not know how many servings were required each day. We do not eat fruit on a daily basis, but definitely eat a small bowl of vegetables in each meal. However, fruits are eaten twice of thrice a week'.

However, the answers to this question were different in the other rural area, Borolekha *Upazila*, as workers with a local nutrition project had been very active in the community, teaching the residents about the necessary daily intake of fruits and vegetables. The majority of rural respondents assumed by they consumed the appropriate volume of fruits and vegetables every day.

In the urban areas, the participants were more particular and conscious about their daily intake of fruits and vegetables. Notably, the urban participants reported eating vegetables three times daily; however, the volume of these servings did not exceed 200g (the field investigators demonstrated a bowl measurement of 200g of food to estimate). While only about 50% of the urban participants said they ate fruit every day, all said that vegetables should be included in at least two meals, and that a serving of fruit was sufficient to constitute a single meal.

Cooking preference: Cooking preference largely depended on the presence of children in the family, not the participant's nutritional knowledge or the procedure. Rural participants explained that:

'We rarely ate meat or fish with vegetables as these items are too expensive to eat with every meal. When we cook, we prepare meals according to the preferences of our children - not based on what we like or what nutritional food we needed to eat'.

In terms of storing cooked or uncooked vegetables, very few households reported owning a refrigerator. Notably, one rural participant said that she would not cook vegetables that had been stored in a refrigerator; the only fresh vegetables that she felt comfortable storing were sweet gourd and ash gourd. In the urban areas, people mostly ate vegetables with fish; however, the respondents also noted that they sometimes did not eat any fish or meat with leafy vegetables. People in the urban areas did not have any reservations when it came to cooking refrigerated vegetables.

Theme 2: Barriers to Eating Fruits and Vegetables

***Taste preference*:** Poverty and a shortage of land were mentioned frequently as reasons why rural participants could not obtain enough fruits and vegetables. However, all participants unanimously acknowledged that 'taste preference' was a major influence in their selection of fruits and vegetables.

More diversity of opinion was observed among the urban participants. For instance, some respondents mentioned similar points:

'I do not like sweet gourd because vegetables are not supposed to be so sweet, they are supposed to be savoury. I avoid pointed gourd as well because the idea of seeds inside a vegetable does not feel right'.

Time was also a significant factor for the urban participants, with most reporting they would not eat leafy vegetables (one participant said bitter gourd) at night because they believed doing so would cause gastritis or diarrhoea. Furthermore, some participants reported that they avoided eggplant and ash gourds, claiming that they caused allergies and potentially paralysis of the body.

Social events and family influence: Family composition and social events also influenced the participants' food habits. In general, the respondents said that fruit consumption increased when a family member was ill, but that vegetable consumption decreased, as vegetables taste bitter during illness. Additionally, one respondent stated that having children in the family increased the demand for vegetables, and especially fruit, as children have a greater 'demand' for food than the adults. One female participant described the family context in a different manner, remarking that:

'Vegetable consumption increases in the family after children are born and added to the family. Kids don't eat much vegetables; the mother eats more vegetables after birth because she needs more energy at that time to keep up with child rearing'.

During festivals, the people of Bangladesh eat more meat and fish than vegetables, as it is believed that guests are equivalent to God or the Creator and one is obliged to serve them their best (i.e., most expensive) food. Furthermore, the ability to serve one's guest meat and fish is also a marker of social status. However, greater quantities of fruit are consumed during the Hindu festival of worship, or "Puja", as the community members are obliged to offer fruit and sweets to the Saraswathi or Lakshmi Goddess. Additionally, the Hindu worshippers are required to eat an exclusively vegetarian diet until the arrival of the final day of the festival. In contrast, during the holy month of Ramadan (month of fasting), Muslims in Bangladesh consume more fried items and meat than vegetables, along with fruit and fruit juice.

Superstitions regarding food culture: Superstitions and social norms are barriers to the consumption of many varieties of fruit and vegetables. Some fruits (e.g., figs) are not eaten for the simple fact that people in the community have never eaten them, instead leaving them for the rodents and snakes. In the field investigation, it was reported that Hindus in the rural areas of Moulavibazar abstain from eating red radish and jujube during the Bengali month of *Magh* (first month of winter) due to the popular belief that these foods impede a woman's ability to conceive a child. In both the rural and urban areas, most respondents said they never eat jute leaf at night or any fruit on an empty stomach. One participant described this practice, stating that:

'We don't eat leafy vegetables at supper. If a snake bites, the person will die, as the poison won't fully come out, even after applying a tourniquet; leafy vegetables are like that. If we are not careful, we will have to pay the price with a high cost. For this reason, we avoid leafy vegetables at night'.

There are many myths in both the rural and urban areas regarding what not to eat during pregnancy. For example, pregnant women are forbidden to drink coconut water, as superstition holds that 'those who violate these rules, their kids' eyes will be white'. Similarly, pregnant women are not allowed to eat bamboo shoots, as there is a superstition that doing so will cause one's child to 'look like a monkey'. Moreover, pregnant women are also barred from eating nigella seeds as, 'these would make the face dark as the seeds' dark color'.

Formalin in fruit and vegetables: In both rural and urban areas, the participants reported that the women are predominantly responsible for buying and cooking food for the family. While men do a monthly grocery run that includes rice, pulses, or meat, they rarely do the everyday shopping for vegetables for the household. The female participants explained that they select vegetables based on brightness of color (especially green), firmness, and shine, with nutritional aspects only being considered afterwards or not at all. Three participants said they would always buy the greenest bitter gourd and reddest amaranth. However, one urban participant noted that:

'if the bitter gourd looked too green, it is sure to have formalin. If it looks a little less bright, it has no formalin. That's the one I buy. We are all very scared of formalin in vegetables. We do not have any tool to check them, so we use our own observations and judgements'.

With respect to fruit, there is a popular belief in Bangladesh society that all bright coloured fruit, especially apples, grapes, oranges, and pomegranates, are full of formalin, and therefore not healthy to consume.

Price of safe vs. unsafe food: The field data revealed that the price of fruits and vegetables was as important as the safety of these items. There is a popular belief that fruits or vegetables containing formalin will look better and be purchased by more affluent people. In contrast, if the item appears a little rotten, the price in the marketplace will drop, as there will be less demand. Only low-income people will consider buying these items, as they are the only ones this demographic can afford.

All respondents in a rural FGD expressed deep concern about food safety with respect to fruits and vegetables. They unanimously agreed to a respondent's statement who stated:

'I would consider paying more for local fresh products with no pesticide rather than buying low-priced chemically treated fruits and vegetables. If the price is higher for the product , I would rather purchase a smaller amount of that item'.

It is worth noting that the price was the main concern of the majority of urban participants, as most believed that 'there is no pesticide-free item' in the market place. As a result, most urban respondents stated that they would eat the cheaper fruits and vegetables than the ones that are labelled as 'safe and pesticide-free' ('because there is no such thing as pesticide free'). Only one urban participant mentioned that she would be willing to pay more for safer food.

Theme 3: Ways And Means to Increase Consumption

Home-based gardening: Participants in rural areas said that having land surrounding the house and receiving subsidized seed from the government would increase the production, and eventually consumption, of fruits and vegetables. As the rural study area was a lowland community, one participant suggested:

'Flash-flood and water logging is a regular thing here in the low-land. Most produce are washed away even after a slight rain. Raising the seed bed of the home-based garden could potentially save the seeds and let us enjoy more home-grown fruits and vegetables'.

The respondents also suggested that receiving lessons on how to cook vegetables could help them maximize the nutrition they receive from them.

Collective awareness within family: When the rural participants were asked how to increase fruit and vegetable consumption, their replies were generally uniform, with most viewing the issue in terms of the distribution of duties and responsibilities among family members. One respondent summarized this sentiment as follows:

'Men's duty is to increase production or buying the product at the right time; children's duty is to tell what their preferences are; women's duty is to collect the vegetables from their surroundings or to tell their male counterpart what to buy based on the taste preference of all household members. Their (women) duty lies also with cooking according to the taste preference of the family members'.

Most participants agreed that, if the children do not want to eat vegetables, they must be taught. The participants opined that such lessons should be developed and taught within the family environment, as well as in the school curricula. One respondent pointed out that children follow what their parents eat, and that parent should therefore lead by example and eat healthy food.

Some respondents noted that cooking practices in Bengali cuisine often entail 'over-cooking' vegetables and other items; therefore, these traditional cooking practices need to be changed. The respondents observed that, while using more oil or frying food for a longer time makes it tastier for the children, these practices are also unhealthy. They suggested that a campaign to raise awareness about the adverse health effects of certain traditional cooking practices, particularly among the women, is urgently needed.

Community level awareness: According to the rural participants, the local community can help to increase the consumption of fruit and vegetables in many ways. For instance, the respondents suggested that wealthy farmers could help poor farmers by providing them with production materials, or community leaders could accumulate barren lands and allocate them to poor farmers. The participants also suggested that Muslim community members may decide to eat healthier if *Imams* spoke about the benefits of eating fruit and vegetables in their weekly *Jummah khutba* (sermon).

Expert Knowledge and Perception Model

The experts/policymakers' perceptions on fruit and vegetable intake are summarized in Table 3 according to three thematic areas: i) why and how to eat fruits and vegetables; ii) barriers to eating fruits and vegetables; and iii) ways and means to increase consumption.

Table 3: Expert/Policymaker Perception and Knowledge Model.

Theme	Sample comments from the experts/policymakers
Why and how to eat fruits and vegetables	*"Not all expensive food will have more nutrition in it. One piece of amla (Indian gooseberry), which is very cheap, would satisfy the need for vitamin C for a day."*
Barriers to eating fruits and vegetables	*"There is a prominent historical reason why people in Bangladesh eat less fruits and vegetables: it is mainly because of perpetual poverty among the population."*
	"Farmers need to understand the demandof the conscious consumers so that those products can be found year-round. More educated and conscious people are in the city, which is why city people are more into eating vegetables year-round."
	"There is a tendency among young working couples to buy more fast food than in previous generations. They are too exhausted to cook after work; thus, readymade fried chicken becomes the solution to all their problems."
Ways and means to increase consumption	*"Not using chemicals or pesticides is not a practical solution, as commercial production is necessary for meeting the demand at home and abroad for a LMIC like us."*
	"These days, kids listen more to their teachers than their parents. If the teachers are appropriately educated about food, the kids will abide by them more."

Theme 1: Why and How To Eat Fruits and Vegetables

Scientific knowledge: In contrast to the public, the experts/policymakers took a more technical approach to the question ofwhy vegetables and fruits are important. One government official explained that:

'There are three main food groups: i) body building foods, such as proteins (milk, meat, chicken, pulses); ii) energy giving foods, such as carbohydrates and fats (cereals and sugars); and iii) protective foods such as minerals and vitamins (fruits and vegetables).Among these foods, fruits and vegetables are the most neglected, especially by young people'.

In addition, it was observed that the price of food does not necessarily correlate to nutritional quality, as 'not all expensive food would have more nutrition in it'. One respondent illustrated the underlying fallacy of the notion that price and nutrition are closely related by pointing out that 'one piece of Amla (Indian gooseberry), which is very cheap, would satisfy the need for vitamin C for a day'.

Cooking procedure: Several expert/policymaker respondents discussed the limitations of traditional cooking methods and procedures, which often involve deep frying or overcooking vegetables, fish, and meat. One respondent explained that, in general, the public does not know how to cook food properly to obtain the maximum amount of vitamins, minerals, and protein. He added that:

'There are two types of iron: one that comes from animal-based proteins and another that comes from plant-based protein. In both cases, people must cook or prepare these foods using citric acid in order to unlock the iron content'.

This same principle applies to calcium and vitamin D, as optimal calcium absorption is dependent on the intake of vitamin D, whether through supplements or from exposure to sunlight.

Theme 2: Barriers to Eating Fruits and Vegetables

Historical preference: According to the experts/policymakers, food habits, land scarcity, and production capability are the underlying barriers to the sufficient intake of fruits and vegetables in Bangladesh. One agricultural economist described this as follows:

'There is a prominent historical reason why people in Bangladesh eat less fruits and vegetables: it is mainly because of perpetual poverty among the population'.

He added that, in the past, the production of fruits and vegetables was insufficient to meet year-round demand, as they were only produced only in specific seasons. To fill this deficit, the public usually used a carbohydrate like rice. Additionally, decreases in the amount of arable land over time have reduced the production of fruits and vegetables to subsistence level:

'Production on one's own land was the only way to have fruits and vegetables. Otherwise, people had to buy these items from the local market the rest of the year. People got used to eating less of the expensive fruits and insufficient amounts of vegetables in their daily routine. Eventually it became the culture, and it has gotten stronger day by day'.

Dysfunctional market influence: The expert/policymaker respondents underscored volatility in the marketplace as one of the main reasons why fruit and vegetable consumption in Bangladesh remains so low. On this matter, one respondent opined that producers/farmers need to be more innovative to respond to the year-round demand for fruits and vegetables, especially in the towns and cities:

Farmers need to understand the demand of the conscious consumers, so that those products can be found year-round. More educated and conscious people are in the city, and that is why city people are more into eating vegetables year-round.

Some of the expert/policymaker respondents highlighted various deficiencies in the supply chain that can lead to food adulteration and consequently impact fruit and vegetable consumption. As one respondent explained:

'Distortions in the supply chain change the market price and quality of vegetables. They come to consumers after traveling down a long chain of market actors. Because of this long chain, the product might become rotten, and this is when damage control becomes very relevant, like medicine, to keep the product fresh for a longer period of time'.

Westernized food culture: Since the 1990s, Bangladesh's economy and society at large have undergone global economic integration (i.e., globalization), which has resulted in rapid changes in food habits, especially in urban areas. The respondents in the expert/policymaking group observed that the adoption of Westernized food culture has had a detrimental effect on fruit and vegetable consumption in Bangladesh, especially in the cities. One respondent elaborated on this point as follows:

'There is a tendency among young working couples to buy more fast food than in previous generations. They are too ex-

hausted to cook after work; thus, readymade fried chicken becomes the solution to all their problems'.

Another responded discussed the situation of the urban family, pointing out that:

'Children usually follow their parents when developing their food habits. As their parents don't eat much fruit nowadays, children don't do what they are told [with respect to eating healthy]; rather, they do what their parents do'.

Misconception of pesticide and formalin use: While the respondents in the public group identified the use of pesticide, herbicides, and formalin by farmers and others in the supply and value chains to protect and preserve fruit and vegetable crops as a major health concern, the experts/policymakers largely viewed such concerns as being rooted in 'misconceptions'. One expert mentioned that, in the past, Persistent Organic Pollutants (POP) were the default pesticides used on crops, with standard doses remaining in the produce for three to four months after application. However, progress in the field of agricultural science has significantly reduced the longevity of pesticide residue, with 99% of current pesticides providing fast action and rapid degradation.

Some of the experts/policymakers also highlighted misconceptions about formalin among the public. As one expert explained:

'Any vegetable that contains fibre does not absorb formalin. A simple water bath could wash out formalin easily. Formalin in protein like meat or fish is more detrimental to health'.

Overall, the expert/policymaker respondents argued that food safety issues are not related to the use of chemicals per se, but are more a matter of their use inappropriate amounts, and the timing and method of their application.

Theme 3: Ways And Means to Increase Consumption

Protective cultivation: To increase the consumption of fruits and vegetables, several experts/policymakers suggested enhancing supply through agricultural extension activities. Some respondents explained that there are specific cultivation procedures for different agricultural zones, and such zone-specific procedures must be applied to further increase productivity. As one expert pointed out, there are 30 agro-ecological zones in Bangladesh, and growers need to know the specific needs of each zone.

'A technology exists where one can grow fruits and vegetables at the same time. This multiplies productivity. Floating cultivation and saltwater cultivation are fairly new technologies, but these technologies are not known to all. There is not much connection between agricultural authorities and the growers. These issues need to be addressed for the successful extension of activities'.

Awareness creation about benefits of consumption: The experts/policymakers identified a lack of knowledge and awareness about the nutritional benefits of fruits and vegetables as the core issue for the low consumption of these foods among the population. In addition, they noted that this issue is compounded by the fact that food habits are deeply rooted in tradition and culture. Most expert/policymaker respondents agreed that changing food habits will be much more difficult than changing cultivation methods due to the historical roots of these habits. To this end, they suggested that a nationwide rigorous awareness campaign promoting the motto, '*Food should be medicine, medicine should be food',* may be successful in effecting change in food habits. The experts/policymakers further noted that media coverage of this campaign, which will promote balanced and safe food intake, will be an essential tool in raising awareness about these issues.

Many experts/policymakers also suggested that educational initiatives focused on the children could be an effective approach to altering food habits. One respondent suggested that it would be necessary to provide teachers with training on this subject matter to achieve this goal. He stated that,

'These days, kids listen more to their teachers than their parents. If the teachers are appropriately educated about food, the kids will abide by them more'.

Privatization of the market: In discussing the means and ways of enhancing fruit and vegetable consumption, several experts/policymakers emphasized the need for more privatization and consolidation of the land and agricultural sectors:

'There are only a handful of cold-storage facilities in the country, which is not enough for all the production. If bigger companies were attracted in this field, many more cold-storage facilities would be built, which would eventually reduce post-harvest loss'.

Some respondents viewed the long supply chain as a major reason for price hikes and suggested that this could be controlled via contract farming. They suggested that a demand-induced production model like contract farming would encourage farmers to procure a better price for their products. Furthermore, contract farming is a good approach to mitigate price depression due to overproduction and over supply.

Ending the formalin myth: Most of the experts/policymakers thought that the use of no chemicals or pesticides was not a viable option, as commercial production is necessary to meet food demand on a countrywide scale. They also unanimously agreed that eliminating the 'formalin myth' is a major requirement to increasing the consumption of fruits and vegetables in Bangladesh.

According to the respondents, significant quantities of mangoes were crushed by law-enforcement agencies during 2016 because the mobile courts were given the power and authority to determine whether their volumes of formalin residues exceeded the legal limit. The respondents alleged that these mobile courts were using faulty detection equipment and methods that did not account for the fruits' own hidden formaldehyde (e.g., formaldehyde is naturally occurring in apples at 22.3mg/kg).

One expert suggested that the formalin issue could be avoided completely if the government restricted the harvesting of mangoes to before May 25th (i.e., before the ripening stage), as this would curb the use of formalin and insecticides.

Discussion

The objective of this study was to determine and juxtapose the perceptions and knowledge of the public and experts/policy makers regarding the barriers and facilitators of fruit and vegetable consumption in Bangladesh. The themes that emerged during this work were synthesized in three broad categories: i) why and how to eat fruits and vegetables; ii) barriers against eating fruits and vegetables; and iii) means of increasing consumption.

(Table 4) presents a synthesis of the public and expert/policymaker perception and knowledge models, as well as the gaps that were observed between these models. As is evident, there are notable differences between the understandings and responses of the general public and experts/policymakers. In some cases, the respondents in the public group held on to certain misconceptions due to personal experience; however, this personal experience also often provided new perspectives relating to complex issues and practical solutions. In this section, we explore the differences and similarities in the responses of the public and expert/policymaker groups in relation to the current literature and the findings of other comparative studies.

Table 4: Comparison of the public's and experts/policymakers' knowledge and opinions, along with gaps in perception.

Themes	Public	Expert/Policymaker	Gaps
Why and how to eat fruits and vegetables	-Lack of knowledge. -Cooking preferences.	-Scientific knowledge. -Cooking procedures.	- Experts/policymakers mostly emphasised technical definitions and cooking procedures. - The general public lacks this information.
What are the barriers to the consumption of fruits and vegetables	-Taste preference. -Social events and family influence. - Superstitious food culture. - Formalin in fruit and vegetables. - Price of safe vs. unsafe food.	- Historical preference. - Dysfunctional market influence. - Westernized food culture. - Misconception of formalin and pesticides.	- General public perceive the barriers mostly in personal context. - Habitual and cultural influence was more prominent in every barrier. - Experts/policymakers perceived barriers from a broad country context. - Focused mostly on the market dimension.
Ways and means to increase consumption	- Home-based gardening. - Collective awareness in the family. - Community-level awareness.	- Protective cultivation. - Creating awareness about the benefits of consumption. - Privatization of the market. - Ending the formalin myth.	- Experts/policymakers' solutions are mostly production- and market-oriented. - Awareness programme prescribed by the experts/policymakers was more focused on mass scale or the supply chain. - General public-consumers called for an increase in awareness at the personal, family, and community levels.

Why and How To Eat Fruits and Vegetables

Regarding the first theme, the participants in the public group primarily viewed healthy eating as necessary for gaining energy to work and 'a must' for the brain development of their children. In contrast, the most important public opinions in the literature hold that healthy eating, especially fruit consumption, and is a critical element in preventing disease [2]. Unlike the experts/policymakers, who rely on scientific and specialized knowledge, the public's mental and knowledge map is more reliant on experiential knowledge. However, the respondents in the public group also had some misconceptions about the recommended daily intake of fruits and vegetables. It appeared that, as a result of local project activities, participants from one rural zone were more aware of how much fruits and vegetables they were supposed to be eating each day compared to the respondents from the other rural zone.

In contrast, the experts/policymakers identified fruits and vegetables as being the most important protective components of the food pyramid, as well as the most neglected food group among the general public. It is apparent that the experts/policymakers gained their knowledge from specialized education and training, whereas the public gained their knowledge from their peers and surrounding resources, for example, health and NGO workers and neighbours.

Another key difference between the public and experts/policymakers was observed in their responses regarding cooking procedures and their effect on nutrition. Whereas the experts/policymakers focused more on cooking procedures that would preserve the nutritional value of the food, the public placed more emphasis on taste preferences and maintaining traditions. As in the present study, a few other studies have found that healthy eating is strongly influenced by the family environment, especially if a female or a child is present in the family [2].

Barriers to Eating Fruits and Vegetables

The second theme aimed to identify barriers to eating fruits and vegetables. When asked to describe the largest impediments to eating enough fruits or vegetables, the rural respondents in the public group identified poverty and not having enough land to practice horticulture as the top two barriers. Conversely, the urban respondents gave two separate responses for fruits and vegetables: while taste was cited as the most important factor related to vegetable consumption, safety was the dominant issue when it came to fruit. Taste preference has also been frequently mentioned in other studies exploring barriers to eating fruits and vegetables [38].

The experts/policymakers also agreed that, historically, poverty and land scarcity have played a key role in shaping current taste preferences and the low levels of fruit and vegetable consumption. The experts/policymakers also agreed that food safety concerns among consumers in Bangladesh area fairly new phenomenon that emerged after the 2005 formalin incidents. Similarly, a study of expert views on the effectiveness of food stamps (i.e., Supplemental Nutrition Assistance Program (SNAP)) in the USA found poverty and the high price of nutrient-rich foods to be the major reasons why such interventions were not fully effective [20].

According to respondents in the public group, the influence of work culture, family norms, and social events were also major barriers to fruit and vegetable consumption. In Bangladeshi culture, as in many traditional societies, 'signalling' the social status and honour of one's family can only be performed by serving expensive fish and meat dishes during social and family occasions. In Bangladesh, there is a belief regarding the social status of food: low status food is often called 'poor man's crops', and expensive foods are considered 'rich man's crops' [15,16]. In contrast to public sentiment, the policymakers placed more focus on distorted market 'signalling' and problems stemming from along supply chain. According to the policymakers, the solely profit-seeking mentality among many of growers and the mar-

ket's vulnerability to volatility has increased uncertainty relating to supply and the price of the fruits and vegetables. As a result of these changes in price, fruits and vegetables have become even more inaccessible to the general public in Bangladesh.

While public opinion relating to barriers was informed by many of the superstitious food norms that permeate Bangladeshi society, the experts/policymakers' concerns focused more on the adoption of Westernized food culture in the cities in recent decades. Even though the experts cited the current rise of Westernized junk food as a major reason for the reduced consumption of fruits and vegetables in Bangladesh, the concerns expressed by the public responders did not touch upon junk food culture directly.

The general public strongly believed that most fruits and vegetables in Bangladesh contain unhealthy amounts of formalin, with this suspicion being more prominent for fruits than vegetables. In contrast, the experts/policymakers suggested that danger due to formalin content in fruits and vegetables is a myth that is rooted in technical errors associated with the first major broadcasted case in 2005. In the aftermath of this incident, public discontent over food safety placed immense pressure on the government to initiate a mobile court system, which collected $13,971 in fines from 16,000 cases in its first year of operation [26]. However, both the experts/policymakers and the general public agreed that concerns relating to formalin are a major impediment to promoting the consumption of fruits and vegetables.

Several studies have found concerns relating to pesticide residue as a major barrier to the consumption of vegetables [2]. However, the urban respondents in the public group believed there was no such thing as a product free of chemical residue, and hence, did not give much weight to pesticide use in their decision making. Policymakers agreed that the overuse of pesticide could result in unsafe food, but they also noted that this outcome was more likely to occur due to unskilled and untrained growers. Even though the public and the experts/policymakers agreed that chemical pesticides are an impediment to healthy eating, the public focused more on the health effects of pesticides, while the experts/policymakers focused on the cause of the problem (i.e., grower's lack of necessary skill).

Means to Increase Consumption

Both the public and experts/policymakers suggested a variety of ways to increase fruit and vegetable consumption. The first and most prominent suggestion from the public respondents was to enable more home gardening using government-subsidized seeds. The female participants also suggested that they would be willing to change their cooking practices if they were given lesson on proper cooking procedures and taught about nutrition.

In many cultures, the decision-making roles for men and women are defined similarly to hunter-gatherer and pre-industrial farming cultures, where men hunted for meat and women gathered vegetables and fruits. As a patriarchal society, there is a perception in Bangladesh that men are the main decision-makers when it comes to purchasing groceries. However, in the context of present-day Bangladesh society, our findings, along those of a few other studies, indicate that women are the sole decision-makers with regards to purchasing groceries [25,41]. Studies in many high income countries showed that middle aged and elderly women are more concerned about eating healthy food than others [8,25]. Several Bangladesh studies (e.g., Mustafa et al., 2021) cited that men are more likely to consume healthy food than women in Bangladesh. This may have little to do with health concern, rather is a reflection of the patriarchal culture in the subcontinent where men are supposed eat first and more than the women. An analysis of the eating patterns of the men and women, or husband and wife, in the same household would likely provide a clearer perspective on this finding.

Similar to Say's law, which states 'supply creates its own demand' [42], the experts/policymakers suggestions for increasing fruit and vegetable consumption mostly focused on the supply side (production) of the problem. However, the general public emphasized demand-driven solutions. For their part, the experts/policymakers suggested that teaching farmers about protective cultivation and the privatization of the market, encouraging more contract farming, and enhancing awareness through mass media could all potentially improve the supply of fruits and vegetables, and therefore consumption.

An emphasis on the supply–side solution by the policymakers is common in the developing agrarian society, mostly due to post-harvest loss and insufficient domestic production. In Bangladesh, 13.5% of post-harvest loss occurs for grains and up to 40% loss for fruits and vegetables [11,44]. Except for shrimp, no other food product is exported in high volume, whereas almost all major food items are exported. Each year more than 100 metric tonnes of fruits and 50 metric tonnes of vegetables are imported [17]. Attention to increase value-adding food products in the country is therefore needed.

Furthermore, a study in Iran revealed that, for nutrition education, targeted interventions in schools or other educational institutes are highly effective, as children area link between the family unit and educational messaging [45]. Indeed, nutritional education is part of the elementary and secondary curriculum in a number of countries, including China, South Africa, and England [12]. Notably, the public's suggestions targeted educational interventions (i.e., for women of the households or children) have widely examined in the literature.

A recent study revealed that higher education in the absence of adequate job opportunities would not result in increased fruit and vegetable consumption [27]. While we recommend continuing efforts to increase educational levels among Bangladeshi women, it is also necessary to create employment opportunities and to bring about a change in gender relationships at the household level.

The results of this study strongly suggest that the effectiveness of food and health policy can be enhanced by focusing on region-based interventions as such initiatives are more responsive to the social and economic realities of the communities. Regarding policy formulation, governmental agencies in Bangladesh should focus on increasing opportunities for education, beginning with the addition of nutrition lessons to primary and secondary curricula. NGOs should also promote Behaviour Change Communications (BCC) promoting the importance of fruits and vegetables, particularly for female audiences. However, while this approach can be effective, it is also slow and takes longer to yield results. Monitoring the safety and nutritional quality of food served at local restaurants and the implementation of appropriate regulatory measures by relevant governmental departments are also necessary to increasing the intake of fruits and vegetables.

Different social, cultural, and religious factors, as well as variations in lifestyle, habits, nutritional knowledge, and cooking styles may influence fruit and vegetable consumption. However, these factors were not addressed in the present study. Further research should be conducted to examine the impact of these potential explanatory factors on fruit and vegetable consumption. As an LMIC, it may not yet be effective for Bangladesh to devote significant effort to indigenous and organic cultivation, as most producers and consumers are not familiar with the correct definition of organic. However, the demand for organic food is slowly growing in Bangladesh; further research should be pursued to understand how effective organic or Indigenous cultivation practices can be in reducing NCDs.

There were several limitations to the study. In our interviews with the experts/policymakers, they emphasized that the public's fear of formalin is a myth. However, there might be some unconscious bias in this statement, as most of the expert interviewees were government civil servants.

The target interventions suggested in this work are aimed at behavioural change among people with low income and less education, especially women and children. This work did not consider how to change the mind-sets of people with higher incomes or lower levels of awareness, or males in general.

Since this self-reported information was entirely dependent on the respondent's capacity and memory, some data may be over or underestimated. In the present study, it was not possible to capture the aspects of seasonal variations, gender-dimension or other socio-economic variations. Finally, the sample size was small and therefore the inferences made in this work should be taken with caution.

Conclusion

This study sought to understand the similarities and differences between the perceptions of the public and experts/policymakers in Bangladesh regarding barriers to consuming the recommended daily intake of fruits and vegetables, as well as ways of increasing consumption. In doing so, we aimed to show experts/policymakers the gaps in current interventions and policies, and to identify effective policy directions to enhance the consumption of fruits and vegetables in Bangladesh and, thus, curb the rise non-communicable diseases.

Our study was inspired by the mental model approach, which conventionally takes expert opinions as the benchmark of knowledge, perception, and solution. However, the modified mental model approach shows that learning is not a one-way process that flows from the experts to general public [19]. Rather, the adapted mental model approach confers equal status to public perception and knowledge, thus making it a parallel framework. The present study has attempted to utilize this feature of the modified mental model.

In departing from the conventional mental model approach, we attempted to capture the perceptions and knowledge of the general public and experts/policymakers' to broaden the policy-intervention horizon of healthy and safe food consumption. This nuanced and complex approach revealed that experts tend to define any health hazard of importance based on technical knowledge, while the public relies more heavily on personal experiences.

While the experts/policymakers discussed barriers to and means of increasing fruit and vegetable consumption, they kept their horizon within the broader context of production (i.e., the supply chain and market), whereas the public's perspectives mainly focused on social norms, family, social events, and social status. Instead of a mass awareness program, the respondents in the public group emphasized providing more education to parents, especially the women of the household who control the kitchen. From the findings of this study, it is apparent that target group interventions (school, women, etc.) will work better alongside the necessary mass awareness programs. Ultimately, this research shows that it is necessary to engage both the public and experts in developing interactive interventions and policies aimed at reducing the prevalence of non-communicable diseases in Bangladesh.

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Conflict of Interest

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of the article.

Ethical Standards Disclosure

This study was conducted according to the guidelines laid down in the Declaration of Helsinki and all procedures involving research study participants were approved by the University of Manitoba Joint Research Ethics Board. Written and verbal (where appropriately needed) informed consent was obtained from all subjects. Verbal consent was witnessed and formally recorded.

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