Perceptions about Varieties of Brown Rice: A Qualitative Study from Southern India

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ABSTRACT

Consumption of whole grains, such as brown rice, compared to white rice can decrease the risk of type 2 diabetes mellitus. This qualitative study conducted in 2009 sought to identify factors that can act as barriers to or promote acceptance of brown rice as a staple food among South Indian adults (n=65). Using purposeful sampling, eight focus groups were conducted among adults with normal body mass index and adults who were overweight, aged 24 to 47 years, living in slum and non-slum sites in Chennai, a city in Southern India. These focus groups, conducted in Tamil, the local language of Chennai, were homogenous by sex. The focus groups were audiotaped after obtaining consent. Results were transcribed and coded according to four major themes that emerged during the focus group discussions, including culture and dietary practices, factors influencing rice preferences, awareness and perceptions of brown rice, and barriers to and factors influencing acceptance of brown rice. Overall, the majority of participants favored eating rice and rice-based foods. Tradition largely dictated the specific form of rice that people consumed. Awareness about the nutritive properties of brown rice was poor and was cited as a major barrier to its acceptance. In addition, participants tended to consider cooked rice that was neither white nor long-grained to be inferior. However, they believed that although convincing people to switch to brown rice would be a slow process, promoting its healthful benefits could serve to popularize it.
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An estimated 285 million people have diabetes worldwide, and an alarming increase to 438 million is expected by the year 2030 (1). Global estimates of health expenditure on diabetes will total at least US$376 billion in 2010 and US$490 billion in 2030, and most countries will spend 5% to 13% of their national health expenditure on diabetes (2). Currently, India has 50.8 million people affected with diabetes (1). The prevalence of diabetes among adults participating in the Chennai Urban Rural Epidemiology Study was 14%, representing a 72% increase in prevalence during 14 years of follow-up (3). The escalation in diabetes incidence is occurring as global free trade continues to fuel rapid economic and nutrition transitions in India, especially in urban settings. These transitions are accompanied by a shift in dietary consumption toward more highly refined carbohydrates, fats, and animal products (4). In Chennai, India, we found that nearly half of daily energy intake came from refined grains, and that white polished rice constituted >75% of refined grain intake, which is associated with a higher risk of metabolic syndrome (5). In addition, evidence shows that the rise in type 2 diabetes among the urban South Indian population is strongly associated with an increase in obesity (6). In addition, a recent study also from South India showed that refined grains (predominantly derived from white rice) were positively associated with risk of type 2 diabetes (7). This is supported by recent data from the Nurse's Health Study and the Health Professional's Follow-Up Study in the United States, which suggest that substitution of brown rice for white rice was associated with a substantially lower risk of type 2 diabetes (8).

Rice continues to be one of the major cereal staples in India, but the quality of rice grains during the last few decades has shifted from traditional hand-pounded rice (undermilled grain) to more polished white rice (refined grain), mainly because of the advent of double-roll sheller mills aimed at improving rice yield (9). Improvement in carbohydrate quality by replacement of white rice with whole-grain foods such as brown rice is likely to have a beneficial effect on biomarkers for diabetes and cardiovascular disease risk and, ultimately, on diabetes risk itself. However, no randomized controlled trial has been conducted to evaluate the impact of brown rice substitution at meals on lowering diabetes risk. Given the com-

pelling evidence from observational studies of whole grains and type 2 diabetes (10), a randomized trial is a necessary next step to determine whether brown rice substitution at meals is effective in lowering diabetes risk.

Focus groups have been shown to be particularly useful for formative research (11) because they shed light on the influence of culture, socioeconomic status, and health on dietary preferences. They also aid in understanding people's perceptions of acceptability and potential barriers that could prohibit acceptance of a product. The purpose of this research was to conduct a qualitative study using focus groups to identify factors that can act as barriers to or promote acceptance of brown rice as a staple food among South Indian adults.

METHODS

Participants

Overweight adults (Asian-specific body mass index [calculated as kg/m^2] cut point for overweight ≥23) (12) and adults with normal body mass index (≥18.5 to 22.9) living in slum and non-slum residences in Chennai, aged 18 years and older, and for whom rice was the preferred staple were recruited using purposive sampling. The 2001 Census of India (13) defines *slum* as a compact area of at least 300 people or approximately 60 to 70 households of poorly built congested tenements, in an unhygienic environment usually with inadequate infrastructure and lacking proper sanitation and drinking-water facilities. By including participants from slum and non-slum areas, we attempted to obtain perceptions from diverse socioeconomic groups. Our rationale for including participants by weight status was to understand potential differences in perceptions between people at higher risk for type 2 diabetes and the general (healthy) population.

The Madras Diabetes Research Foundation in Chennai, established contact with key people in the selected slum and non-slum areas to recruit participants for the Focus Group Discussions (FGDs). People living in and around the key contact's home in the non-slum area were approached for study participation by visiting their homes. The FGDs were conducted in the key contact's home. In the slum area, recruitment and FGDs were held in the government-run Integrated Child Development Center, a day-care service for local children aged 2 to 5 years.

Study Design and Analysis

The study was conducted using a cross-sectional qualitative design. Ethical clearance was obtained from the Institutional Review Board of the Harvard School of Public Health and the Ethics Committee of the Madras Diabetes Research Foundation. The FGDs were conducted in Tamil and audiotaped after obtaining written informed consent from each participant. They were scheduled at a time that was convenient for participants and care was taken to ensure privacy and confidentiality.

All participants who agreed to participate in the FGDs were required to taste two varieties of rice, namely Bapatla rice (both raw and parboiled forms) and the parboiled form of Uma red rice (which owes its name to the red

Rice	Description
Bapatla raw rice	This form of rice is obtained by dehusking the Bapatla variety paddy, which is then polished to obtain Bapatla raw rice.
Bapatla parboiled rice	Bapatla variety paddy is soaked in water, steamed, dried, dehusked, and polished to obtain Bapatla parboiled rice.
Parboiled red rice	A variety of rice with pigmented (red) bran popular in Kerala, a southern state.

Figure 1. Description of rice varieties commonly consumed in Tamil Nadu. These varieties, which are commonly available in Tamil Nadu, are all highly polished (8% to 10%). Brown rice (0% polish) is not freely available in the markets.

pigment of its bran). Figure 1 provides a description of these two rice varieties and its two forms (raw and parboiled). These rice varieties were polished to 0%, 2%, and 4% (varieties of brown rice include both unmilled [0% polish] and undermilled rice [2% and 4% polish]; unmilled rice would contain 100% bran content, and undermilled would have some of the bran content only). In India, there are >200,000 varieties of rice (14), but the most commonly consumed varieties in the South are Ponni, Sona Masuri, and Bapatla. These rice varieties are highly polished (8% to 10%) and are available in both raw and parboiled forms. Brown rice is currently not freely available in the market. The rice at 0%, 2%, and 4% polish (both raw and parboiled forms) and Uma red rice (in the parboiled form) were specifically milled for this study.

The FGD participants were given the opportunity to examine the uncooked rice varieties before tasting the cooked forms (Bapatla raw rice, Bapatla parboiled rice, and parboiled Uma red rice), each at three different degrees of polishing (0%, 2%, and 4%). The rice was served with *sambhar* (a gravy dish made with lentils, some vegetables, and Indian spices) in the presence of the research team during a period of 3 days, with each day being allocated for one form (ie, raw, Bapatla parboiled, and Uma red parboiled) to avoid confusion. Thus, on the first day, each participant was served three samples of Bapatla raw rice at three different degrees of polishing (0%, 2%, and 4%), on the second day they were served Bapatla parboiled rice at three different degrees of polishing, and on the third day they were served Uma red rice at three different degrees of polishing.

A focus group guide was developed to ensure consistency across groups. Probes for discussion were built into the guide to allow for a thorough understanding of the topic. The guide included such topics as perceptions of dietary preferences, influence of factors such as culture, economic status, and health in determining dietary habits, decision-making in the family regarding dietary intake and perceptions on introducing brown rice (or equivalent) as the main staple in the diet. Trained, sex-specific social scientists conducted each FGD and were assisted by a note-taker who recorded nonverbal behavior, made notes, and plotted sociograms that gave a visual representation of the dynamics of the group discussions. Presence of sex-specific moderators and note-takers ensured

Culture and Dietary Practices
"All the people who are in this area are lovers of rice, unless a person happens to be sick or having some health problem, people prefer to eat rice . . . those who are forced to eating tiffin items like idli, dosa, etc, sometimes do so half-heartedly, people are habituated to eating rice" (male, normal BMI[a], Slum group).
Factors Influencing Rice Preference
"Price is not very important, the rice should be good" (female, overweight, Slum group).
"Only if the rice is white in color will we be satisfied and then only will our family members like to eat it. . . . There have been several occasions when we have bought rice from our village which was not the white variety. Our family members did eat it but they did not relish it and so I cannot cook it on a daily basis" (female, overweight, Non-Slum group).
"Here in Chennai if we buy this kind of rice (referring to the unmilled variety), it is a prestige issue. People will think poorly of us, it is a question of status" (female, normal BMI, Slum group).
Awareness and Perceptions of Brown Rice
"People think that since this rice does not look good it is of cheap quality . . . people test the appearance of the rice first, if they find it bulky and less white they may not like it" (male, normal BMI, Non-Slum group).
"With this rice you have to chew really hard . . . it is like cow chewing food. This rice sits like a stone in the stomach, one can only eat less quantity otherwise it sits heavy and takes a long time to digest" (male, normal BMI, Slum group).
"You see in a household if there are four members and only two are willing to accept the less polished rice and the other two are unwilling, then one will have to cook two varieties of rice and that is problematic" (female, overweight, Non-Slum group).
"How much ever awareness you create, people will understand and change only when they are compelled to for health reasons" (male, normal BMI, Non-Slum group).
Factors Influencing Acceptance of Brown Rice
"Only if they (the government) say that some disease will affect people if they do not eat this unmilled variety of rice, will people eat this rice. Otherwise people will continue to eat the rice they have been used to. Just like medicines, they are bitter but people still consume them for health reasons, the same way people will start eating this rice based on health reasons" (male, normal BMI, Slum group).
"People may think that they have been buying this costly rice for so long and why is someone ready to sell rice cheaper in rate saying that it is good for health? Answering these questions will be difficult as people nowadays always think that the more expensive a product the better it is" (male, normal BMI, Slum group).

Figure 2. Selected qualitative comments from focus groups discussions organized by emergent themes. [a]BMI=body mass index.

that participants, mainly women, did not feel inhibited and participated freely. Efforts were made to encourage all participants to take part in the group discussion.

All FGDs were first transcribed verbatim into Tamil by one of the research assistants and then translated into English by a bilingual person not associated with the study. The principal investigators then independently reviewed the Tamil and English transcripts and looked for potential discrepancies or incomplete data. Wherever these were present, the audiotapes were listened to again and discrepancies were resolved. A framework analytical approach (15) was used for data analysis. This process involved a number of distinct though highly interconnected stages beginning with familiarization with data, identifying a thematic framework, indexing or sifting through data and sorting quotes, charting or selection of quotes and placing them under the appropriate thematic category, mapping, and final interpretation. Each transcript was coded inductively by two independent coders to enhance validity. After coding a few interviews, the coders compared the coding schemes each had developed and then resolved any differences in coding. Once all the FGDs were coded, segments of text that were related to a common theme were pieced together and, in this manner, emergent themes were identified.

RESULTS
Sixty-five adults participated in eight FGDs conducted separately for men and women and ranging in size from seven to 10 people (see Figure 2). Participants consisted of 19 women and 15 men for the four FGDs, which took place in the slum region (age range=24 to 47 years) and 16 women and 15 men for the non-slum region (age range=25 to 47 years). Half of the participants from the slum areas had completed primary school as their highest level of education, and 32% of participants had a sedentary occupation. In contrast, the majority of participants from the non-slum areas had completed a postgraduate education (42%) and 61% were employed in a sedentary occupation.

Emergent Themes
The analysis revealed the following four broad themes:

- culture and dietary practices;
- factors influencing rice preference;
- awareness and perceptions of brown rice; and
- factors influencing acceptance of brown rice.

Quotes from FGD participants organized by emergent themes are shown in the Table.

Culture and Dietary Practices
Overall, dietary habits in this population are rice-based; for example, breakfast foods, generally referred to as *tiffin* items, were: *idli* (made with soaked parboiled rice and split dehusked black gram, which is ground into a batter and allowed to ferment for 6 to 8 hours, after which it is steam-cooked in molds), *dosa* (an Indian pancake made with the same *idli* batter that is poured on to a flat iron griddle and shallow-fried with a few drops of oil until

Table. Descriptive characteristics of participants (n=65) in eight focus groups seeking insight into people's perceptions on varieties of brown rice

Factors	Slum (n=34)				Non-Slum (n=31)			
	Men (n=15)		Women (n=19)		Men (n=15)		Women (n=16)	
	Overweight (n=7)	Normal BMI[a] (n=8)	Overweight (n=10)	Normal BMI (n=9)	Overweight (n=8)	Normal BMI (n=7)	Overweight (n=9)	Normal BMI (n=7)
	mean± standard deviation							
Age (y)	39±7.7	31±6.5	31±7.1	29±5.3	34±9.5	32±3.44	40±7.3	31±5
BMI	25.4±2.4	20.3±0.7	26.6±3.8	21.2±1.0	28.2±4.4	19.7±3.1	28.2±3.1	22.1±0.7
	n							
Education								
Nonliterate	2	0	1	0	0	0	0	0
Primary (grades 1 to 5)	2	1	6	8	0	0	1	1
Secondary (grades 6 to 12)	3	6	2	0	1	0	1	0
College (technical education, under graduation, postgraduation)	0	1	1	1	7	7	7	6
Sedentary occupation	1	3	4	3	7	6	9	7
Marital status								
Unmarried	1	5	0	0	1	3	0	0
Separated	0	0	0	1	0	0	0	0
Married	6	3	10	8	7	4	9	7

[a]BMI=body mass index (calculated as kg/m^2).

it turns golden brown), and *pongal* (a double-boiled soft-cooked dish made of rice and green gram split dehusked legumes with Indian spices such as black pepper, cumin seeds, and ginger). Occasionally, wheat-flour−based foods like *poori* (dough rolled into small flat circles and then deep fried in oil) or *bread and breakfast cereals* were consumed by people living in non-slum areas, but rarely by people living in slums. A common practice in the slum area was to buy a breakfast comprised of *idli, dosa,* or *pongal* from local vendors because they lacked the infrastructure or the time to prepare these at home (ie, electric grinder and refrigerator to store the ground batter). Lunch predominantly consisted of rice with *sambhar*, *rasam* (soup made of tamarind water, tomatoes, and cooked lentils with Indian spicy curry powder usually eaten with rice), and a vegetable dish.

Nonvegetarian participants followed a similar diet with the addition of one or two meat items once or twice a week. Choices for the evening meal ranged from wheat-flour−based breads like *rotis* (flat bread baked with/without ghee/vegetable oil on a griddle) eaten with a vegetable/lentil gravy or a chicken/mutton curry, tiffin items such as *dosa* or *idlis* to rice and *sambhar*. The *roti,* a staple food typically consumed in the northern parts of India, has become increasingly popular in the South for both taste and the popular perception that it is healthier. However, participants from the slum area rarely made *rotis* because it was perceived as being labor-intensive, time-consuming, and, more importantly, not a South Indian tradition. Overall, eating rice and rice-based foods was most popular.

Factors Influencing Rice Preference
Parboiled and raw rice were the two most commonly consumed forms of rice. Those habituated to eating par-boiled rice disliked raw rice; similarly, those used to eating raw rice disliked parboiled rice. Parboiled rice, however, was considered to be more nutritious compared to raw rice. Other FGD participants did not perceive any major differences between the two and had no reservations about eating either form, apart from the fact that raw rice tended to get easily overcooked. Generally, tradition dictated the specific form of rice that people ate.

When purchasing rice, whether raw or parboiled, the most important feature sought was color, followed by taste and texture. The long-grained and white varieties were the most favored. The more expensive, highly polished variety of rice was seen as a status symbol, and people were skeptical of rice that was not white or long-grained. The nutritive content of rice rarely influenced its selection. There was mixed awareness among participants, ranging from those who were partly aware to those without any knowledge of the nutritive properties of rice and foods in general. Participants believed that because these same foods had been consumed by their family members for generations, it must be healthy. Some participants were quick to point out that the quality of the food products they were consuming today was poor compared to what earlier generations had consumed, thereby exacerbating their health risks. Others maintained that they had neither the time nor inclination to think about good nutritive or balanced diets, what mattered most were taste and convenience.

Awareness and Perceptions of Brown Rice
Participants' awareness of varieties of brown rice (0%, 2%, and 4%) was mixed. Some participants reported that a particular kind of hand-pounded rice that was consumed in their native villages was similar to the brown rice that was being discussed. Some were even aware that

brown rice was a healthier variety of rice, but also reported that it was not available in the markets in cities and towns. Others were not familiar with brown rice. Among those who were aware of brown rice, its brownish color, different taste, chewy texture, and "ruptured look" of the cooked brown rice grains had a deterring effect. Participants believed that until all household members were willing to accept any of these varieties of brown rice, it would be difficult to give up the highly polished rice (8% to 10%) that people were used to eating. In this context, young people were considered to be the most difficult group to change, whereas older people, particularly those with health concerns or those otherwise motivated to improve their health, would be more willing to accept these varieties of brown rice. Although the general consensus was that getting people to accept this rice would be difficult, some participants suggested that endorsement from health professionals and the government could be a potentially effective strategy to encourage consumption of brown rice.

Factors Influencing Acceptance of Brown Rice

According to participants, apart from color, size, texture, and habit, another major barrier to the acceptance of brown rice was poor awareness about it and its nutritive properties. People were so accustomed to eating white rice, and rice that was not white in color was considered inferior. Taste was another important issue and people were not satisfied unless they had eaten white rice. They had grown used to eating expensive varieties of rice, and brown rice, because of its appearance and texture, was believed to be of poor quality. To convince people to change to another rice staple that looked and tasted different was seen as not only difficult, but a very long and slow process.

Suggestions to promote these varieties of brown rice ranged from advertising special recipes in which brown rice was the main ingredient; having celebrity film actors endorse varieties of brown rice via mass media; giving people free samples of this rice; and getting the government to educate people about its health benefits, thereby enhancing acceptability. One more suggestion was to introduce people to eating the undermilled (2% and 4% polish) varieties of brown rice rather than the unmilled 0% polish brown rice as a first step toward acceptance of brown rice in the future.

DISCUSSION

These FGDs revealed that traditional practices, inadequate knowledge about the health benefits of adapting to brown rice, and opinions about rice appearance (ie, that rice must be white and long-grained after cooking) were major deterrents to behavioral change. Environmental factors included poor availability of varieties of brown rice in the local markets. Interventions that address these factors might be more effective eliciting change in people's rice consumption patterns.

India is a country rich in diversity as evidenced by the varied languages, cuisines, and cultures of people across regions. Food plays an important role in the lives of most Indian families and, to a large extent, tradition deter-

mines the types of foods consumed and their manner of preparation. Although people living in the northern parts of India predominantly consume wheat, those in the South consume rice as the staple food. Over time, acculturation has taken place with wheat-based breads like *rotis* (both whole wheat and refined) being consumed by many people in South India for their taste and perceived health benefits. A recent study has shown that *roti* has a low glycemic index (45.1 [standard error of the mean=3.5]) (16); however, glycemic index values from standard testing procedures are currently unavailable for brown rice, which is less likely to be found in local South Indian markets. This is a limitation that precludes our ability to make clear comparisons between the two staples.

Because rice is the preferred staple in the South, any change in the types of rice consumed is likely to be met with resistance and will require continued reinforcement of positive messages aimed at enhancing people's acceptance of unpolished rice. Some participants across slum and non-slum groups, women more so than men, indicated both interest and willingness to adopt eating these varieties of brown rice. However, they also highlighted that it would be a gradual process requiring the cooperation of their families to make it a part of their regular diet. Strong support from the government and medical community would be likely to facilitate this process by both adding credibility and building awareness about the nutritive properties of brown rice.

Awareness of varieties of brown rice was rather poor among the participants. This is interesting because before the advent of mechanical rice milling (developed to improve the shelf life and yield of rice), hand-pounded rice was commonly consumed by Indian families. There has been a tremendous surge in the number of mechanical rice mills in India, ranging from seven in 1963 to 35,088 mills in 1999 (17). Thus, white rice quickly became very popular (especially the whiter and more expensive varieties, which became a symbol of status), and hand-pounded rice faded from the markets. The findings from the FGDs are consistent with this observation. Participants, whether from the slum or the non-slum groups, believed that rice that was chewy with bulky grains and, more importantly, not white in color, was not of good quality and should be cheaper in price. Similar findings emerged from a study in China in which brown rice was associated with unpalatable taste and low quality (18). In the present study, there were no differences in perceptions between overweight adults and those with normal body mass index across slum and non-slum areas, a feature potentially attributable to the long duration of rice as a traditional staple food.

Even the economically poorer sections of society in Chennai prefer the higher-priced white rice rather to cheaper varieties available in the market. Interestingly, the government of Tamil Nadu, in an effort to benefit the poorer sections of society, has made a cheaper form of both raw and parboiled rice available under the Public Distribution System (9), priced at 1 Indian Rupee per kilogram. The price of rice (both parboiled and raw) available in the open market currently ranges from 25 to 40 Indian Rupees per kilogram. Most of the focus group participants from the slum said that they would never buy the rice sold under the Public Distribution System, as

it did not look white and was believed to be of poor quality. It would be interesting to see whether this attitude is pervasive among the poorer sections of society. Important to note is that brown rice is an expensive commodity in the current market, possibly due to lower demand. Healthier food choices are priced higher, which could also prove to be another major deterrent.

In terms of the strengths of the study, qualitative methods like FGDs are useful tools to obtain insight into people's perceptions and behavior. Such methods enhance the validity of findings by virtue of their nonthreatening and open-ended approach. Study limitations were that no FGDs were conducted among adolescents, who also influence the kinds of foods cooked at home, and no interviews were carried out with rice millers and distributors, who have an important stake in the rice market and may be able to offer additional insight. Future research should consider addressing these issues.

CONCLUSIONS

This study has highlighted the poor awareness among people about brown rice, its nutritive properties, and the factors that may serve as barriers to its acceptance. Highly polished white rice is the preferred staple among South Indians across socioeconomic groups. Our recently published work (5,7) on the dietary profile and refined grain consumption of urban South Indians has shown that almost half of daily calories come from refined grains and white rice is the predominant refined grain consumed in the three main meals. Switching to any one of these varieties of brown rice from white rice might serve to elicit a lower glycemic response. These results provide an important context for future randomized controlled studies on substitution of brown rice for white rice.

References

1. Unwin N, Whiting D, Gan D, Jacqmain O, Ghyoot G, eds. *IDF Diabetes Atlas*. 4th ed. Brussels, Belgium: International Diabetes Federation; 2009.

2. Zhang P, Zhang X, Brown J, Vistisen D, Sicree R, Shaw J, Nichols G. Global healthcare expenditure on diabetes for 2010 and 2030. *Diabetes Res Clin Pract*. 2010;87:293-301.

3. Mohan V, Deepa M, Deepa R, Shanthirni CS, Farooq S, Ganesan A, Dutta M. Secular trend in the prevalence of diabetes and impaired glucose tolerance in urban South India. Chennai Urban Rural Epidemiology Study-17. *Diabetologia*. 2006;49:1175-1178.

4. Shetty PS. Nutrition transition in India. *Public Health Nutr*. 2002;5: 175-182.

5. Radhika G, Van Dam RM, Sudha V, Ganesan A, Mohan V. Refined grain consumption and the metabolic syndrome in urban Asian Indians. Chennai Urban Rural Epidemiology Study-57. *Metabolism*. 2009; 58:675-681.

6. Deepa M, Farooq S, Deepa R, Manjula D, Mohan V. Prevalence and significance of generalized and central body obesity in an urban Asian Indian population in Chennai, India Chennai Urban Rural Epidemiology Study-47. *Eur J Clin Nutr*. 2009;63:259-267.

7. Mohan V, Radhika G, Sathya RM, Tamil SR, Ganesan A, Sudha V. Dietary carbohydrates, glycaemic load, food groups and newly detected type 2 diabetes among urban Asian Indian population in Chennai, India Chennai Urban Rural Epidemiology Study-59. *Br J Nutr*. 2009;102:1498-1506.

8. Sun Q, Spiegelman D, van Dam R, Holmes M, Malik V, Willett W, Hu F. White rice, brown rice and risk of type 2 diabetes in US men and women. *Arch Intern Med*. 2010;170:961-969.

9. Chattopadhyay PK. Postharvest technology for rice in India: A changing scenario. In: *Rice Is Life: Scientific Perspectives for the 21st Century*. Proceedings of the World Rice Research Conference, Tsukuba, Japan, 2004; 294-296.

10. de Munter JS, Hu FB, Spiegelman D, Franz M, van Dam RM. Whole grain, bran, and germ intake and risk of type 2 diabetes: A prospective cohort study and systematic review. PLoS Med. 2007;4:e261.

11. Ulin PR, Robinson ET, Tolley EE. *Qualitative Methods in Public Health: A Field Guide for Applied Research*. San Francisco, CA: Jossey-Bass; 2005.

12. World Health Organization. *The Asia Pacific Perspective. Redefining Obesity and Its Treatment. International Association for the Study of Obesity and International Obesity Task Force*. Melbourne, Australia: International Diabetes Institute; 2000.

13. Census of India. New Delhi: Government of India, Ministry of Home Affairs; 2001.

14. Achaya KT. *The Illustrated Food of India, A-Z*. New Delhi, India: Oxford University Press; 2009.

15. Ritchie J, Spencer L. Qualitative data analysis for applied policy research. In: Bryman A, Burgess RG, eds. *Analysing Qualitative Data*. London, UK: Routledge; 1994:173-194.

16. Radhika G, Sumathi C, Ganesan A, Sudha V, Mohan V. Glycaemic index of Indian flatbreads (rotis) prepared using whole wheat flour and 'atta mix' added whole wheat flour. *Br J Nutr*. 2010;103:1642-1647.

17. Public Distribution System. Tamilnadu Civil Supplies Corporation. http://www.tncsc.tn.gov.in/html/pds.htm. Accessed March 9, 2010.

18. Zhang G, Malik V, Pan A, Kumar S, Holmes M, Spiegelman D, Lin X, Hu FB. Substituting brown rice for white rice to prevent diabetes: A focus group study in Chinese adults. *J Am Diet Assoc*. 2010;110:1216-1222.