

## Editorial

### **Can the diabetes/cardiovascular disease epidemic in India be explained, at least in part, by excess refined grain (rice) intake?**

The prevalence of chronic non communicable diseases (NCDs) is now reaching epidemic proportions in the developing countries. Indeed, India already has the highest number of diabetic patients in the world (50.8 million) and this is projected to increase to 87 million by the year 2030<sup>1</sup>. Indians have an increased susceptibility to diabetes which can, at least partly, be explained by genetic factors<sup>2</sup>. However, genetic factors alone cannot explain the rapid rise in diabetes prevalence in urban India within a period of three decades<sup>3</sup>. This strongly suggests the role of environmental factors.

Economic progress is inevitably associated with increasing urbanization. In addition to several features of urban life such as physical inactivity and unhealthy dietary practices, outdoor and indoor air pollution tend to increase the prevalence of diabetes and cardiovascular disease (CVD) also in urban India<sup>4</sup>. The association between physical inactivity and obesity and the prevalence of diabetes has been established<sup>5,6</sup>.

Cereals are staple diet in India, and carbohydrate consumption constitutes the bulk of the total calorie intake. Since 1980, the percentage of carbohydrate intake in Indian diets has remained relatively constant (55-65% of total calories), which is not much higher than that recommend by the WHO guidelines for the prevention of chronic diseases<sup>7</sup>. However during this period, the prevalence of diabetes has increased from 8 per cent (1980) to 16 per cent (2006) in urban India, specifically in Chennai<sup>3</sup>. We hypothesize that this could reflect changes in the quality of grains consumed today *i.e.*, use of refined (*e.g.*, highly polished rice) instead of the whole grains (less polished, hand pounded rice) consumed earlier.

Consumption of whole grains is beneficial while refined grains, which contains only the endosperm (starch) have an adverse effect on cardio-metabolic risk factors including glucose intolerance and diabetes<sup>8</sup>.

Also high carbohydrate diets raise plasma glucose, insulin, triglycerides and non-esterified fatty acids leading to insulin resistance<sup>9</sup>. The quality of the carbohydrate *i.e.*, glycaemic index (GI) and glycaemic load (GL) has also gained importance as a risk factor for development of chronic NCDs, particularly diabetes. Foods with higher GI and GL can cause rapid post-prandial increase in blood glucose and insulin<sup>10</sup> and have been shown to increase the risk of type 2 diabetes and CVD in western<sup>11,12</sup> as well as in Asian populations, specifically in China<sup>13</sup> and India<sup>14</sup>.

The traditional cereal-based Asian Indian diets were not only rich in dietary fibre, but also in other micro and phytonutrients. Use of unrefined carbohydrates, derived mainly from whole grains (unpolished / brown rice or whole wheat) could possibly explain the lower rates of CVD<sup>15</sup> and type 2 diabetes mellitus in India in the 1960s-70s<sup>16</sup>. Unfortunately, for better shelf life, and consumer appeal, rice underwent a high degree of refining and milling (8-12%). As a result, the outer bran and germ portions of intact rice (*i.e.*, brown rice) grains were removed to produce white rice that primarily consists of starchy endosperm<sup>17</sup>. As the unrefined cereals were replaced in India by highly refined cereals, this changed the quality of the carbohydrates to a higher GL.

Refined grains in southern India, mainly consist of polished rice, refined wheat flour (white flour), semolina and ragi (finger millet) flour. Of these, rice is the major contributor (76%, mean 253 g/day)<sup>8</sup> and represents the major source of energy contributing to 66 per cent of the total GL in Chennai<sup>14</sup>. The commonly consumed highly polished white rice in India has an extremely high GI value (approximately 75-80) and the refining process leads to loss of fibre, vitamins, magnesium and other minerals, lignans, phytoestrogens, and phytic acid, many of which may be protective factors for diabetes and CVD<sup>18</sup>.

In a large population based cross-sectional study, the Chennai Urban Rural Epidemiology Study (CURES)<sup>14</sup>, we have recently shown the deleterious effect of refined grains (predominantly white rice) among the Chennai population and showed a strong association with type 2 diabetes and also with metabolic syndrome<sup>8</sup>. We also noted an association between intake of polished white rice and the prevalence of newly diagnosed type 2 diabetes which was independent of age, sex, smoking, alcohol, body mass index, physical activity, total energy, fruit and vegetable intake and dairy products.

In India, cereals continue to be the main staple and provide the bulk of the calories unlike in the west of less than 50 per cent. The average rice intake in India is around 8.5 servings per day, whereas in China it is around 6 servings per day. High GI rice is consumed in high amounts and hence the GL of Indians far exceeds (quintile: 1<sup>st</sup> 259 vs 5<sup>th</sup> 461)<sup>8</sup> that of China (quintile: 1<sup>st</sup> 233 vs 5<sup>th</sup> 322)<sup>13</sup>. This might partly explain why migrant Indians have been consistently shown to have higher rates of diabetes compared to the local population in the Asia Pacific region<sup>19</sup>. Undoubtedly, other factors such as genetic susceptibility, physical inactivity, air pollution and psychological factors could play a role. We have earlier shown that allele Pro12Ala polymorphism of the peroxisome proliferator-activated receptor (PPAR)-gamma gene was protective against type 2 diabetes in Caucasians whereas it did not protect Indians<sup>2</sup>. The higher GI/GL of the Indian diet due to intake of refined grains may play an important role in making Indians more susceptible to diabetes compared to Europeans, Chinese and other races.

In the National Urban Diabetes Study (NUDS) study<sup>20</sup>, the prevalence rates of diabetes was higher in three southern cities (Hyderabad, Chennai and Bangaluru) where rice is consumed more frequently, compared to three northern cities (Delhi, Kolkata and Mumbai) where wheat, is consumed more frequently. Other studies have reported higher prevalence rates of CVD in southern India compared to northern India<sup>21</sup>. It is tempting to attribute these differences directly to rice intake. However, other confounders, including other dietary factors, physical activity, different rates of obesity and possibly genetic differences, should be considered before any conclusions regarding rice intake and prevalence rates of diabetes/CVD are drawn and, this is obviously an exciting area for future epidemiological research. A carefully done national survey on diabetes could throw more light on this issue.

Urban Indian diets are not yet 'westernized' and the dietary pattern is still characterized by a high intake of refined cereals, predominantly derived from polished white rice. Moreover, those who eat more rice, eat less of virtually all other foods such as legumes, tubers, fruits and vegetables and dairy products<sup>8</sup>. Particularly, the fruit and vegetable consumption is very low and 90.9 per cent of the population consumes less than the WHO/FAO recommended intake of fruit and vegetable<sup>7</sup>. We also showed that higher fruit and vegetable intake explained 48 per cent of the protective effect against CVD risk factors in this population<sup>22</sup>.

Increase in sugar production in India, does not seem (as yet) to reflect in its increased consumption, as indicated in the CURES study, where sugar and sweetened beverages were within the recommended intake as percentage of total calories. In south Indians, neither tubers nor sugars were associated with type 2 diabetes<sup>14</sup>. Sugar intake in this population was mainly in the form of 'added sugar' in hot beverages (tea and coffee), but this only comprised 3.6 per cent of the GL whereas refined grains comprised of 66 per cent of the GL<sup>14</sup>. In the past, the diet was not only rich in whole grains (rich in fiber) but there were also much higher grades of physical activity and this could explain the low prevalence of obesity and diabetes. This scenario is now replaced not only by excess intake of refined grains (low in fibre and micronutrients) but is also associated with sedentary activity and these could be the major drivers of the obesity, diabetes and CVD epidemic in India.

It is unlikely that the total carbohydrate content of Indians can be altered due to centuries of eating high carbohydrate diet. It is thus prudent to encourage the introduction of low GI foods in the market as well as to promote high fibre foods to reduce the dietary GL of the population. Relatively small changes in diet, particularly replacing refined grains such as polished white rice with brown / minimally polished rice could be recommended as measures to reduce the risk of type 2 diabetes/CVD epidemic in India. Prospective and randomized clinical trials have provided additional evidence that replacement of refined grains with whole grains results in reduction of type 2 diabetes and CVD risk factors<sup>23,24</sup>. However, it is difficult to identify such low GI products in the Indian market, as most of the food items consumed in India today have a high GI. Thus, it may be useful to consider the promotion of low GI choices such as brown / minimally polished rice for this population. Moreover, since excess refined grains intake is also associated with less protein and

dietary fibre, it is prudent to advise people on adopting an overall healthy diet approach. Thus, one should encourage increased protein and dietary fibre intake, introduce low fat and lower glycaemic carbohydrate foods and also increase the fruit and vegetable intake. Increasing consumer awareness about the ill effects of high GL diets is also necessary. Healthier dietary choices, along with increased physical activity, could play a vital role in reducing the burden of diabetes/CVD epidemic in our country. These measures could be included as policies to be adopted in the National Programme for Prevention and Control of Diabetes/ Cardiovascular diseases and Stroke (NPDCS), of the Government of India<sup>25</sup>.

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