

Full Length Research Paper

Assessment on the predominance of konzo in Kwilu District

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Konzo is a sudden spastic paraparesis that causes permanent paralysis of the legs and occurs mainly in children and young women. Konzo results from high cyanogen intake and malnutrition caused by a monotonous diet of bitter cassava. The known incidence of konzo in DRC up to 2009 is 3469 cases, but an estimate in 2002 was 100,000 cases. To help resolve this question a konzo survey was made in three health zones in Kwilu District, Bandundu Province, Democratic Republic of Congo (DRC), and the nutrition of those with konzo recorded. Thirty villages (population 22793) in Kwilu District were surveyed for konzo cases, and food consumption scores and mid upper arm circumferences obtained. There were 172 konzo cases with village konzo prevalences of 0.1-17%. The mean konzo prevalence in Masimanimba and Kingandu health zones was much less than in Payikongila health zone, probably because of the higher rate of malnutrition in Payikongila. Since 2009, konzo incidence has increased greatly in Kwilu District and also in 13 villages in nearby Kwango District, where incidence of new konzo cases has been prevented by use of the wetting method. Averaging the data over 495 konzo cases, 48% occurred from 2009 onwards and 52% occurred in the 20+ years before 2009. The very large increase of konzo incidence since 2009 is a public health problem in Bandundu Province, that could be solved by training women to use the wetting method, which removes cyanogens from cassava flour. The wetting method is more direct, effective and cheaper in preventing konzo than broad based interventions.

Key words: Konzo survey, cassava, cyanide, nutrition, sulfur amino acids, food consumption score, mid upper arm circumference.

INTRODUCTION

Cassava contains cyanogens (linamarin and a small amount of lotaustralin) that on consumption liberate cyanide in the

body, which can lead to konzo, an irreversible spastic paraparesis of the legs that occurs suddenly amongst very

poor village people who live on a monotonous diet of bitter cassava (Cliff et al., 1985; Howlett et al., 1990; Nzwalo and Cliff, 2011). Konzo is an upper motor neuron disease that causes permanent paralysis of the legs and affects mainly children and young women after childbirth. Many of these people suffer from malnutrition with low protein intake, in particular a shortfall of the essential sulfur amino acids methionine and cysteine/cystine that are needed for detoxification of cyanide (CN) to thiocyanate (SCN) in the body (Cliff et al., 1985). Konzo occurs in the Democratic Republic of Congo (DRC), Mozambique, Tanzania, Cameroon, Central African Republic and Angola (Bradbury et al., 2011; Allen, 2010) and because of the very large per capita consumption of cassava in Congo (Nhassico et al., 2008) konzo probably occurs there as well. The total number of konzo cases reported up to 2009 is 6788 (Nzwalo and Cliff, 2011), with 3469 cases in DRC, but this is very much less than the true number, because konzo occurs in isolated areas and during crises such as war and drought. An estimate of 100,000 konzo cases in DRC was made in 2002 (Diasolua Ngudi, 2005). In 2010 Action Against Hunger (ACF) in Kwango District, Bandundu Province, DRC, located 2218 konzo cases (Kasonga and Calo, 2011; Delhorne et al., 2012). Konzo occurs in at least four provinces, Bandundu, Kasai Oriental, Kasai Occidental and South Kivu (Chabwine et al., 2011) (Figure 1), but there has been no country wide survey of konzo in the DRC.

Konzo has been prevented in 13 villages in the DRC with a population of nearly 10000 people by use of the wetting method by village women to remove cyanogens from cassava flour (Banea et al., 2012, 2013, 2014a). The wetting method consists of adding water to cassava flour, spreading the wet flour in a thin layer on a mat for 2 h in the sun or 5 h in the shade to allow the escape of hydrogen cyanide gas produced by breakdown of linamarin by the enzyme linamarase (Bradbury, 2006; Cumbana et al., 2007; Bradbury and Denton, 2010). The damp flour is then cooked in the traditional way to make a thick porridge called fufu. The women readily accepted the wetting method and still continued to use it more than a year after the intervention ceased and the method has spread by word of mouth to other villages (Banea et al., 2014b). Furthermore, a correlation has been found between the monthly percentage incidence of konzo and the monthly cyanide intake as measured by the urinary thiocyanate content of children (Banea et al., 2014a). It is therefore likely that konzo results from high cyanide intake from bitter cassava, coupled with a low intake of sulfur amino acids.

It is important to have a good estimate of the total number of people with konzo in DRC and other countries, so that the prevention methods that we have developed can be systematically applied towards the complete prevention of this disease. In this paper we report the konzo prevalence and nutrition of konzo

cases in 30 villages in three health zones in Kwilu District, Bandundu Province.

MATERIALS AND METHODS

Study area

In order to discover the most affected konzo areas in Kwilu District, discussions were held with Kwilu District health authorities in Kikwit in July 2012. Four health zones were identified as most affected Masimanimba, Kingandu, Payikongila and Djuma, but Djuma health zone was excluded for logistical reasons (Figure 1). Thirty four villages were identified as most affected and konzo cases were found in thirty villages.

Food and diseases of the people

The most important food crops are cassava, maize, peanuts, squash and cowpeas. Cassava is the staple food eaten as fufu, mainly with cassava leaves and vegetables. There is some small livestock, poultry, small scale fishing and fish farming for sale. The dry season is from mid-May to mid-August and there is another short dry season in February-March. There are two lean periods in August to November and in March, when household food security is critical and the number of meals is reduced to one meal per day. The most common diseases are malaria, acute respiratory infection, diarrhea, malnutrition and trypanosomiasis.

Health zone visits and survey methods

Discussions were conducted with the health authorities in each of the three health zones and supervisors were identified in each zone. Four supervisors were given training in Kikwit City by the konzo team of Programme National de Nutrition (PRONANUT). Each trained supervisor was responsible for collecting data on konzo cases in the health areas of his health zone. In each health zone the most affected villages were identified first. A census was taken of each affected village and suspected cases of konzo or those with gait difficulties were identified by the community health workers, who are trained to recognise common diseases including konzo and to refer the case to a health centre. Konzo cases were examined by doctors from PRONANUT following a standardised protocol (World Health Organisation, 1996) as follows: (1) a visible spastic walk or run, (2) an abrupt history of the onset of the disease in less than one week in a person in good health, with no further progression of the disease, (3) a bilateral exaggeration of knee jerks and/or Achilles tendon (ankle clonus). The month and year were recorded when konzo occurred. Five surveyors were trained to administer the food household consumption questionnaire for each family with a case of konzo.

Food consumption score (FCS) in konzo household

The food consumption data of 155 households with konzo (some had multiple cases of konzo) were surveyed in the three health zones and this was used to calculate the World Food program food consumption score (FCS) using the equation:

$$FCS = a_{staple} X_{staple} + a_{pulse} X_{pulse} + a_{veg} X_{veg} + a_{fruit} X_{fruit} + a_{animal} X_{animal} + a_{sugar} X_{sugar} + a_{oil} X_{oil},$$

$$= \text{number of days for which each food group was}$$

Where x_i consumed during the past seven days, a_i = weight of each food

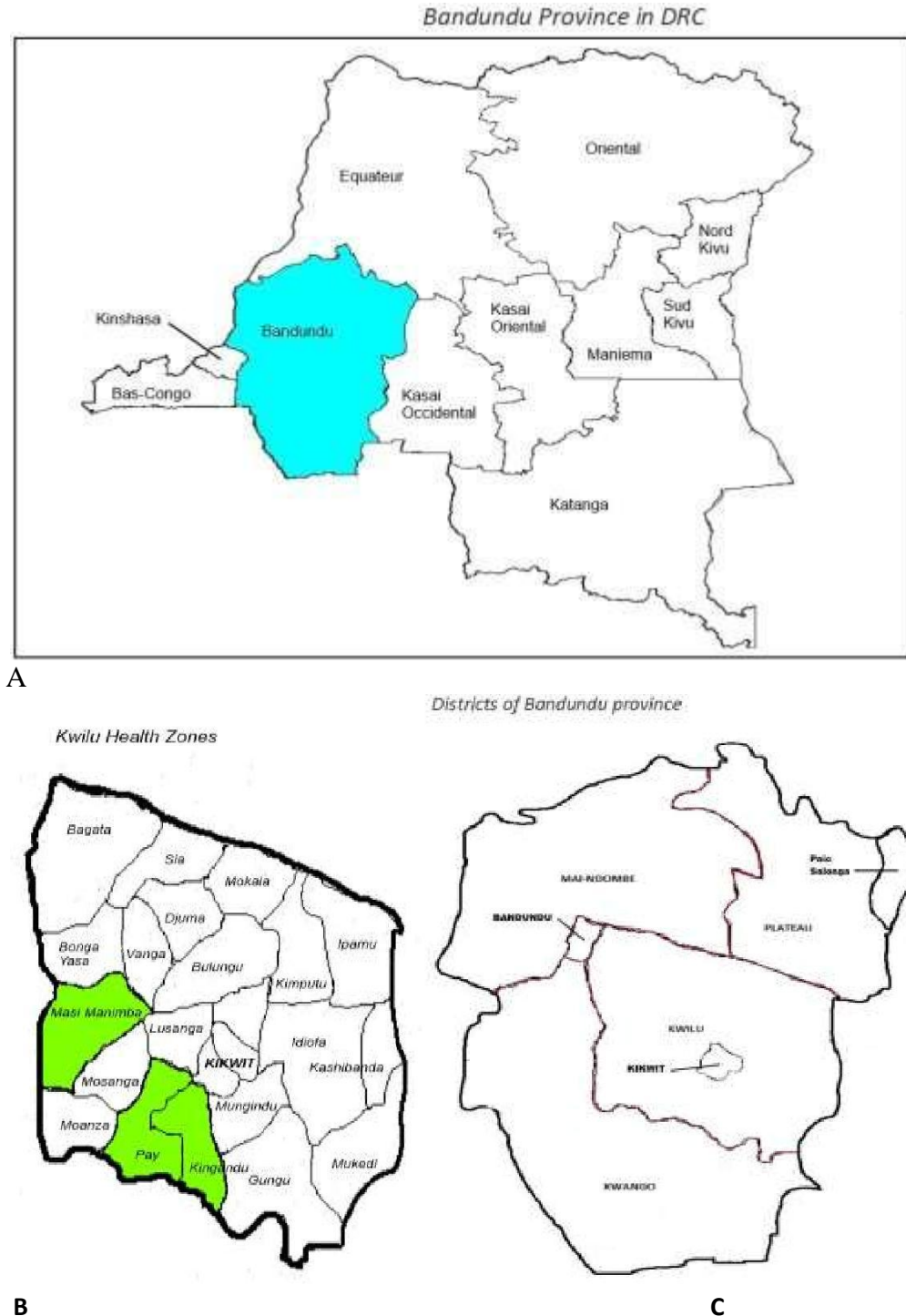


Figure 1. A. The provinces of DRC showing Bandundu, Kasai Occidental, Kasai Oriental and South Kivu where konzo is present; B. Health zones of Kwilu District with the survey ones marked; C. Districts of Bandundu Province.

group as follows: staple (cassava) 2, pulses (beans, peas, groundnuts) 3, vegetables and leaves 1, fruit 1, meat and fish 4, milk 4, sugar 0.5, oils, fats and butter 0.5. The thresholds used were: 0-23.9 for poor food consumption, 24.0-37.9 for borderline food consumption, and ≥ 38 for acceptable food consumption (Interagency Work. Rep. WFP-FAO 2008).

Mid upper arm circumference (MUAC) and nutritional status

The mid upper arm circumference was used in order to identify high-risk malnourished (> 18 years old) konzo patients (Unicef 2012; Projet Sphere). A MUAC of < 210 mm indicated a person with malnutrition. There were 64 konzo patients measured in Masimani-

Table 1. Percentage konzo prevalence in descending order for thirty villages in Kwilu District.

Village	Population	Number of konzo cases	% Konzo
Kongila Ndola ^a	106	18	17.0
Kongila Kianfu ^a	495	38	7.7
Lubamba ^a	341	9	2.6
Kinzefa ^a	420	8	1.9
Kabanga ^b	564	6	1.1
Kiwawa Kapa ^c	1453	12	0.83
Mulasi ^c	248	2	0.81
Kizefo ^c	1153	9	0.78
Kiwawa Pont ^c	1805	13	0.72
Mvudi ^b	564	4	0.71
Makanga ^c	1047	7	0.67
Mashini ^b	734	4	0.54
Kipongi ^c	1104	6	0.54
Kikonga ^c	751	4	0.53
Kimeso ^c	231	1	0.43
Yoshi ^c	467	2	0.43
Cite Masi ^c	734	3	0.41
Sakani ^b	734	3	0.41
Mbeko ^c	1030	4	0.39
Lunza ^c	805	3	0.37
Bibamba ^c	549	2	0.36
Kifunga Centre ^c	2420	6	0.25
Kikongo ^c	400	1	0.25
Kilombo M ^c	405	1	0.25
Kiwamba ^c	534	1	0.19
Kikiama ^c	564	1	0.18
Kimpembe ^c	564	1	0.18
Kiko ^c	734	1	0.14
Kinzenga Q3 ^c	950	1	0.11
Mudigongo ^c	887	1	0.11
Total	22793	172	

^a Payikongila health zone; ^b Kingandu health zone; ^c Masimanimba health zone

mba, 13 in Kingandu and 46 in Payikongila.

Ethics statement

The Ministry of Public Health Ethics Committee in DRC approved the survey protocol, which was also approved by Kwilu district health authorities and health zone health authorities. The chiefs of the villages accepted the census and medical examination of their people for konzo and distribution of a questionnaire on food consumption.

RESULTS

Thirty villages were identified in Masimanimba, Kingandu and Payikongila health zones to be surveyed, 22 in Masimanimba, four in Kingandu and four in Payikongila

health zones. In a population of 22793 people there were 266 people with walking difficulties of whom 172 had konzo, giving a mean konzo prevalence of 0.75% (Table 1). The four villages in Payikongila health zone had the highest konzo prevalences ranging from 17% down to 1.9% with 42% of the total konzo cases. The main group of villages in Kingandu and Masimanimba health zones had konzo prevalences ranging from 1.1% down to 0.11% (with 9 villages recording only one konzo case) and accounting for 58% of the total number of konzo cases. Overall 53% were female and 47% male. Of the women who contracted konzo, 12% were nursing a baby at the time of the konzo attack. The age at onset was 2-4 years, 9%; 5-14 years, 53%; 15-44 years, 34%; 45-55 years, 4%. There was an abrupt onset in less than one day in 83% of cases and the remainder over 2-7 days.

Table 2. Comparison of % konzo prevalence, % malnutrition^a and % nutrition (poor, borderline, acceptable)^b of people in three Kwilu health zones.

Health zone	% Konzo prevalence	% Malnutrition ^a	Nutrition (%) based on food consumption score		
			Poor	borderline	acceptable
Masimanimba	0.44	20	11	28	61
Kingandu	0.66	8	18	6	76
Payikongila	5.4	50	22	38	40

^aBased on mid upper arm circumference (MUAC) measurement of adult konzo patients (Unicef, 2012; Projet Sphere); ^bBased on food consumption score (FCS) of konzo families, see methods (Interagency Work. Rep., WHO-FAO, 2008).

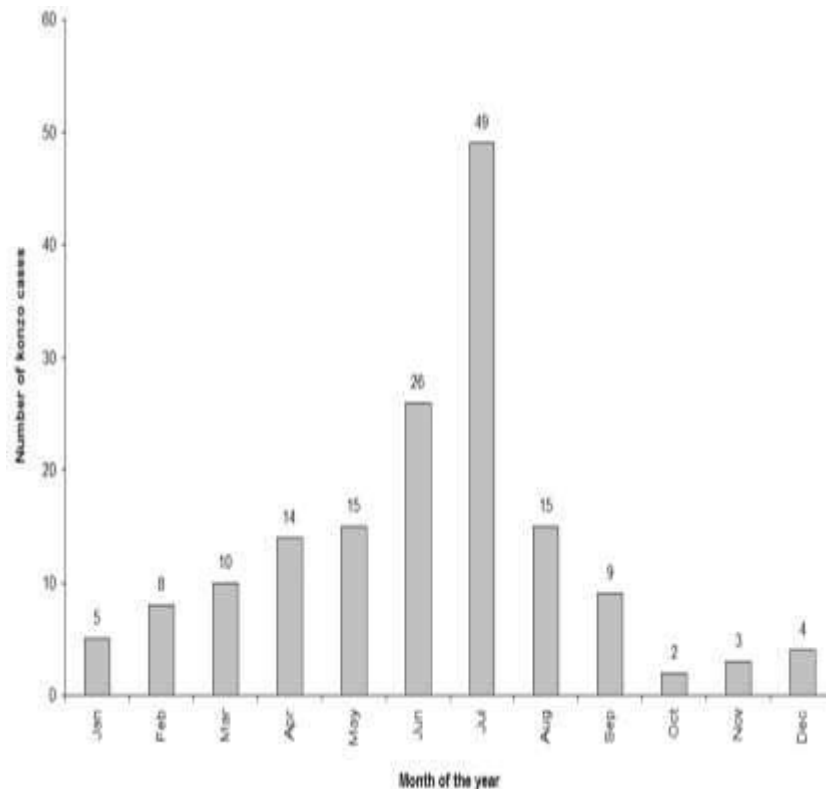


Figure 2. Monthly distribution of onset of konzo cases.

Bilateral exaggerated knee jerks were observed in 96% of cases. Speech disorders occurred in 22% of konzo cases, 17% had blurred vision and 2% goitre. It was found that 7% of people with konzo were unable to walk, 25% needed one or two sticks and 68% walked unaided but with a limp. These numbers have been combined with those from six other konzo studies in DRC and Tanzania (Banea et al., 2014a) and the results (mean +/- SD) are 8+/-5 severe, unable to walk; 26+/-13 moderate, needing one or two sticks; 66+/-12 mild, no sticks needed.

Table 2 shows the mean konzo prevalence in each health zone, % malnutrition among konzo cases measured by MUAC and the nutrition measured by a food consumption survey of the konzo families. The monthly

occurrence of konzo cases is shown in Figure 2 and the years in which they occurred in Figure 3. The peeled cassava roots are soaked (retted) in a pond or a stream or at home for 2-3 days, but only for 1-2 days during the dry season. About one third of the konzo households surveyed had difficulty to ensure proper soaking, due to theft during soaking in 87% of cases or lack of water in 13% of cases. One quarter of households had consumed only one meal the day before the survey in July. Survival strategies used during periods of food shortage (August to November and in March) were to fall back on food gathering, use of less preferred foods and also to harvest crops early. Nearly all households (93%) with cases of konzo had houses made of straw and only 12% had

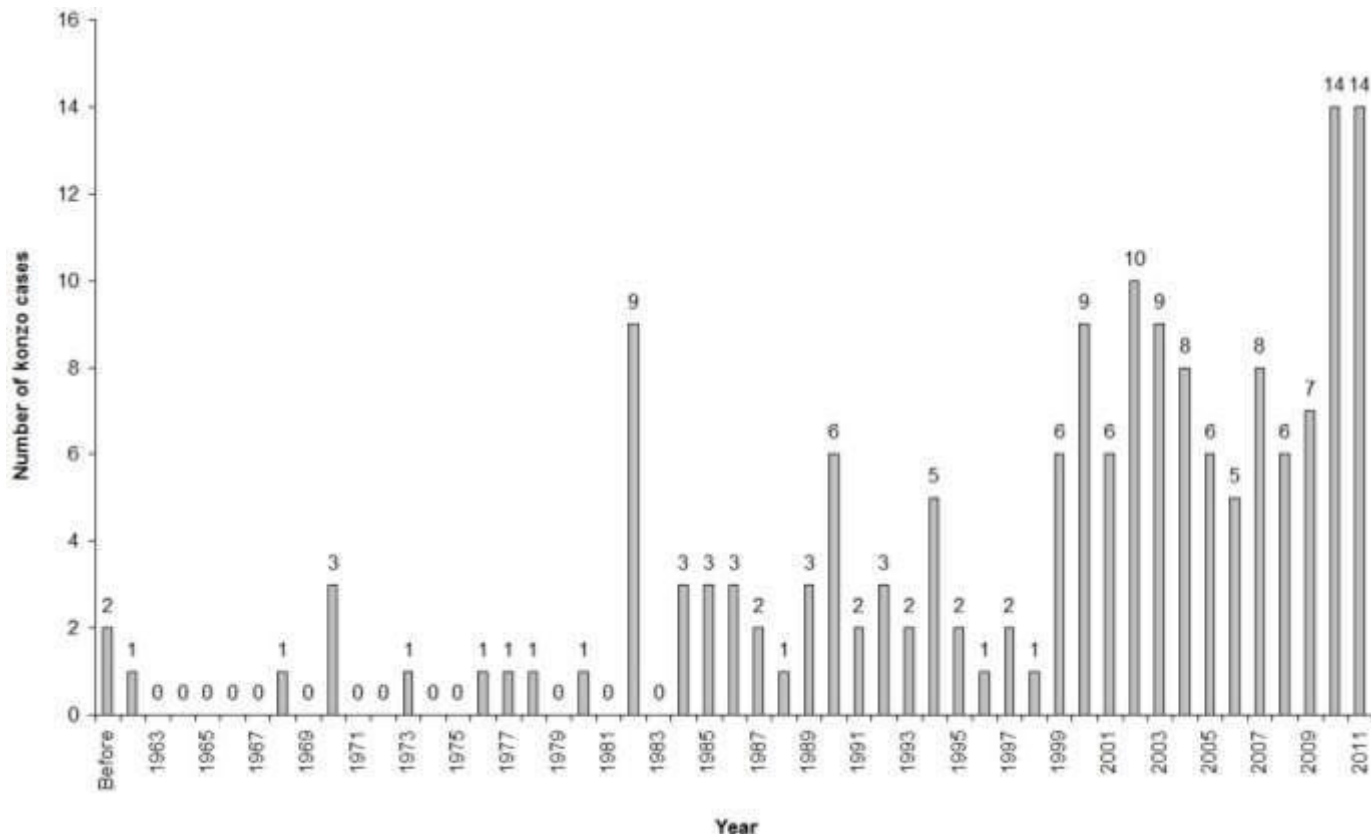


Figure 3. Annual distribution of onset of konzo cases.

access to a source of safe drinking water.

DISCUSSION

The data in Table 1 show that konzo prevalence is very high in four villages of Payikongila health zone with 42% of total konzo cases and much less in the 26 villages of Kingandu and Masimanimba health zones with 58% of total konzo cases. The high konzo prevalence in Payikongila health zone is probably due to the much poorer nutrition and higher degree of malnutrition of konzo cases in Payikongila compared with konzo patients from the other health zones (Table 2). Unfortunately, we do not have the urinary thiocyanate content of the school children, which would have allowed comparison between the cyanide intake of children from each health zone.

In Figure 2, the monthly incidence of konzo throughout the year shows a strong maximum incidence in July, the peak cassava harvesting season in the dry season, which agrees with previous work (Banea et al., 2012, 2013). The survey of konzo families showed that short soaking for 1-2 days instead of 3-4 days (Banea et al., 1992) was common especially in the dry season, which together with a peak in consumption of cassava, caused a peak in both

cyanogen intake and konzo. The yearly incidence of konzo (Figure 3) shows that konzo cases have occurred every year since 1984, with much larger annual numbers since 1999, particularly in 2010 and 2011. This confirms the very concerning results found in 13 villages in Popokabaka and Boko health zones in nearby Kwango district, where konzo incidence has greatly increased since 2009 in this area of Bandundu Province (Banea et al., 2012, 2013, 2014a). By combining the data from this survey and the four interventions, it was found that 48% of the konzo incidences were in the three years from 2009 onwards and 52 % in the preceding 20+ years.

By the successful use of the wetting method by village women to remove cyanogens from cassava flour we have prevented konzo in 13 villages with 9191 people (Banea et al., 2012, 2013, 2014a). Furthermore, we have shown that there is a significant correlation between month by month percentage konzo incidence and monthly cyanide intake, as measured by the percentage of children with high urinary thiocyanate content (Banea et al., 2014a). It is therefore likely that konzo arises from high cyanide intake and malnutrition, specifically a shortfall of sulfur amino acids, also being a factor (Nzwalo and Cliff, 2011). We have prevented konzo by decreasing cyanide intake, but the results in Table 2 suggest that malnutrition may

be an important factor. The importance of malnutrition was evident in three unrelated konzo epidemics in which people of the same ethnic group as those who had high konzo prevalence, but living only about 5 km away had virtually zero konzo prevalence. Those who were protected from konzo in the Mozambique konzo epidemic lived near the sea and consumed fish (Ministry of Health, 1984), as did those in Tanzania who lived near Lake Victoria (Howlett et al., 1992) and those protected in DRC lived in the forest and ate animals from the forest (Banea Mayambu, 1993). Thus, improvement of the diet particularly by inclusion of animal protein is probably a means of preventing konzo. This is part of the cross-sectoral approach used by Action Against Hunger (ACF) (Kasongo and Calo, 2011). The intervention of ACF has reduced konzo incidence by 84% between 2010 and 2011 (Delhourne et al., 2012). The reduction of cyanide intake by educating the women about the cause of konzo and how to use the wetting method to remove cyanogens, is direct, effective and less expensive than the cross-sectoral approach which involves improvement of the diet and other factors. Ideally, reduction of cyanide intake and reduction of malnutrition should be used together (Cardoso et al., 2005).

Conclusion

In three health zones of Kwilu District there were 172 cases of konzo in 30 villages. The villages of Payikongila health zone had much higher konzo prevalences and the konzo cases much poorer nutrition, than in the villages of Masimanimba and Kingandu health zones. Since 2009 there has been a large increase of yearly konzo incidence in four interventions to prevent konzo using the wetting method in nearby Kwango District and also in this survey in Kwilu District. Using the data from the four interventions and this survey it was found that 48% of konzo cases occurred from 2009 onwards and 52% of cases in 20+ years preceding 2009. The use of the wetting method to reduce cyanogen intake has prevented konzo in 13 villages costing an average \$27 per person and is more effective in preventing konzo and cheaper than broad based interventions.

Conflict of interests

The authors did not declare any conflict of interest.

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